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THE SCIENCE AND ART

OF

SURGERY.

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BACON *on Learning.*

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THE

SCIENCE AND ART

OF

SURGERY.

A Treatise on Surgical Injuries, Diseases, and Operations.

BY

JOHN ERIC ERICHSEN, F.R.S., LL.D. (EDIN.),
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SURGEON EXTRAORDINARY TO HER MAJESTY THE QUEEN.
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HONORARY MEMBER ROYAL ACADEMY OF MEDICINE OF BELGIUM AND OF NEW YORK—CORRESPONDING MEMBER OF IMPERIAL AND ROYAL SOCIETY OF PHYSICIANS, VIENNA—HONORARY MEMBER OF AMERICAN SURGICAL ASSOCIATION—OF SOCIETY OF MEDICAL AND NATURAL SCIENCE, BRUSSELS—OF ACCADEMIA DI QUERILI, ROME, ETC., ETC

NINTH EDITION.

REVISED AND EDITED BY

MARCUS BECK, M.S. & M.B. (LOND.), F.R.C.S
SURGEON TO UNIVERSITY COLLEGE HOSPITAL; AND PROFESSOR OF SURGERY IN UNIVERSITY COLLEGE LONDON.

Illustrated by One Thousand and Twenty-five Engravings on Wood.

VOL. II.

LONDON:
LONGMANS, GREEN, AND CO.
1888.

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DIVISION FOURTH.

DISEASES OF TISSUES.

CHAPTER XXXVII.

SURGICAL DISEASES OF THE SKIN AND ITS APPENDAGES.

THE various affections peculiar to the skin, such as eczema, scabies, impetigo, acne, lepra, psoriasis, &c., fall within the province of the Surgeon, and are commonly treated by him in practice ; but, as the consideration of these would necessarily lead into the whole subject of Dermatology, the limits of this work would not allow me to discuss so extensive and special a branch of Surgery ; and I must therefore content myself with the consideration of some of those affections of the skin, which, requiring operative interference, may be more properly looked upon as within the scope of the present Treatise. These diseases may be considered under the several heads of Diseases of the Skin itself, including the various forms of non-malignant ulceration, and the malignant ulcers and tumours, and Diseases of the Appendages of the Skin, as the nails. We have already in Chapter VI. considered the ordinary non-malignant ulcers of the skin, and in Chapter XXXIV. some of the simple tumours that occur in connection with the tissue.

DISEASES OF THE APPENDAGES OF THE SKIN.

DISEASES OF THE NAILS.—The nails may become diseased, as the result of mechanical injury, or as a part of some general cutaneous affection. A violent blow or pinch often partly loosens the nail and causes an extravasation of blood beneath it. It then becomes black and slowly separates. No treatment is required beyond protecting the part by some convenient covering.

In some broken states of health, and especially in persons suffering from squamous disease of the skin, the nails occasionally become blackish or dark-brown in colour, are rugged, dry, and cracked, scaling off, as it were, without any apparent affection of the matrix. This condition, of which I have seen several instances, is best treated by a course of alteratives or tonics, the disease yielding as the general health becomes improved. Arsenic will often be found of great service, either alone or with mercury.

Onychia is a disease of the nails dependent on inflammation of the matrix ; it occurs under two forms, the *simple* and the *specific.*

In **Simple Onychia** there are redness, heat, and swelling usually on one side of the nail, and in the angle of the tissue in which it is implanted ; there is discharge of pus, and the nail gradually loosens, becomes dark-coloured, and somewhat shrivelled, and may eventually be thrown off, a new nail making its appearance below, which commonly assumes a somewhat thickened and rugged shape. This disease usually results from some slight injury, as the running of a thorn or splinter into the finger. The *treatment* consists in cutting away any part of the nail that becomes loose, so that no discharge may accumulate beneath it. The inflammation may be subdued by hot moist applications. In some cases a lotion composed of Liq. Plumb. subacetatis ʒss. Rectified spirit ℥j. and water @ Oj., will be found most efficacious. The application of iodoform is often useful.

Syphilitic Onychia is a more serious affection, and is often dependent on injuries inflicted on the finger during constitutional syphilis. In it a dusky-red or livid inflammation takes place at the sides or root of the nail; ulceration is set up, accompanied by the discharge of sanious and very fetid pus; and large loose granulations spring up at its root and sides, so that the end of the toe or finger that is affected (and this is most commonly either the great toe, the thumb, or the index-finger) becomes greatly enlarged and bulbous in shape. The nail then shrivels, becomes brown or black, and peels off in strips (Fig. 418); after its separation, thick epidermic masses, forming abortive attempts at the production of a new nail, may develop at the base and sides. In the *Treatment*, both local and constitutional means are required. The first and most essential point is to *remove the nail*, either in whole or part, for it acts as a foreign body, and prevents the healing of the surface from which it springs; the ulcer may then be treated with iodoform or well rubbed with the nitrate of silver, and dressed with black wash. Colles recommends fumigating it with a mercurial candle, made by melting a drachm of cinnabar and two ounces of white wax together. The *constitutional treatment* is that of syphilis.

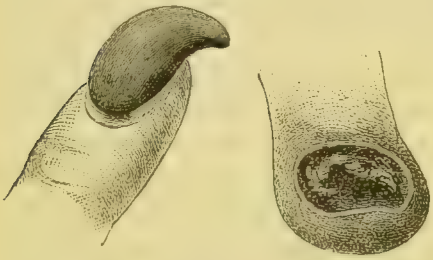

Fig. 418.—Syphilitic Onychia.

Ingrowing of the Nail is an extremely painful and troublesome affection, principally occurring in the great toe, and brought about by wearing pointed shoes, by which the sides of the soft part of the toe are pressed upon, and made to overlap the edge of the nail. An ulcer here forms, the liability to which is greatly increased by the nail being cut square, so that the flesh presses against a sharp and projecting corner of it; this ulcer secretes a fetid sanious discharge, and large granulations are thrown up by it. The consequence is inability to walk or even stand with comfort.

Treatment.—In the very early stages before ulceration has taken place, further trouble may often be prevented by scraping the nail along its middle with a piece of broken glass or a knife, or filing it down till it is about as thin as a sheet of note-paper. At the same time, its free end should be cut short in the middle, and its corners allowed to grow well beyond the matrix, so that the natural edge of the nail and not a sharp angle shall be in contact with the soft parts. When the soft parts begin to overlap the nail various plans have been devised with a view of raising the edge of the nail, and pressing aside the soft structures. I have never, however, seen much permanent benefit result from any of these means; and the only method that is, I think, really serviceable to the patient, is the removal of the whole nail. As this operation is an excessively painful one, the patient should be anæsthetized with nitrous oxide, or the matrix may be rendered insensitive by the ether-spray. The Surgeon holds the diseased toe in his left hand, and then running one blade of a strong sharp-pointed pair of scissors under the nail up to its very root, he cuts through its whole length, and, removing the scissors, seizes first one half and then the other with a pair of dissecting forceps, and twists them away from their attachments. The surface left is still covered by the deeper layer of the epithelium, which becomes dry and hard in a few days. The back of the scissors usually wounds the matrix in the middle line, and here granulations may form. The new nail usually grows straight and healthy. In some rare cases, however, I have seen a faulty direction assumed by it. If this should happen the nail must be again removed, and the matrix dissected away. Avulsion of the toe-nail is usually unattended by danger. I was, however, once called upon to amputate a foot for gangrene, which had followed the operation performed on an elderly person.

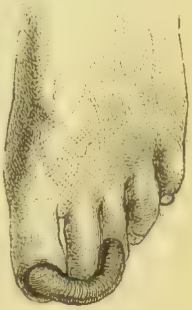

Fig. 419.—Hypertrophy and Deformity of Toe-nail.

Hypertrophy of Toe-Nail. Occasionally from neglect the toe-nail may become enormously hypertrophied and twisted, looking more like a horn than a nail, as in the accompanying drawing (Fig. 419) taken from a patient in whom the nail had been allowed to grow uncut for twenty years, producing complete lameness. I removed the whole nail in one piece by avulsion, and completely restored the utility of the foot.

DISEASES OF THE SKIN.

Lupus.—Under the term *lupus* various affections of the skin were formerly included, which had but little in common with each other beyond running a chronic course and leading to destruction of the cutaneous tissues, with or without ulceration. It is now limited to two diseases which, although included under the common name, are in reality quite distinct. These affections are distinguished as Lupus Erythematosus and Lupus Vulgaris. When the term lupus is used alone it is applied only to the latter disease.

Lupus Erythematosus.—This disease was originally described as an affection of the sebaceous follicles. Hebra in 1845 gave it the name of Seborrhœa Congestiva. It is now generally known by the name of Lupus Erythematosus. It consists essentially in a chronic inflammation, affecting chiefly the sebaceous follicles and the tissues immediately surrounding them. There is an increased secretion of sebaceous matter from the follicle by which the acini of the gland become dilated and the duct widened. The parts immediately surrounding the follicle show the ordinary signs of chronic inflammation, the capillaries being dilated and the tissues infiltrated with small round cells. The disease terminates in destruction of the follicles, and the chronic inflammatory products partly degenerate and are absorbed, and partly become developed into cicatricial tissue.

The disease commences as a sharply defined red patch, the colour of which disappears almost entirely on pressure. The redness is most marked round the orifices of the follicles. The spots may be isolated or in groups, and vary in size from a pin's head to a split pea. The patch soon becomes covered by an adherent scale, which is greasy to the touch. If this be removed it is found to be continuous with the plugs of altered sebaceous matter filling the dilated ducts of the follicles. The patches itch slightly, but are not actually painful. As the disease advances the spots slowly increase in size at the circumference, while the central parts become paler, slightly depressed, and cicatricial—the thin scar-tissue being dry like parchment and often scaly. There is no tendency to suppuration or ulceration. Another and less common variety of the disease is described in which it commences as numerous discrete spots, and spreads by the appearance of fresh patches, rather than by extension from a single centre. Lupus erythematosus is most common on the cheeks. It may occur also on the ears, lips, scalp, and the backs of the hands. The disease runs an extremely chronic course, often lasting many years, and causing great disfigurement. It has a great tendency to relapse after apparent cure. Attacks of erysipelas are not uncommon during its progress. The cause is unknown. No distinct connection has been traced between it and scrofula or syphilis, and it is not hereditary or contagious. It commences usually in young adult life after the eighteenth year, and is most common in women.

Treatment.—No drug exerts any specific influence on the disease, and the constitutional treatment consists therefore merely in attending to the general health on ordinary principles. Locally, Kaposi states that he has found the application of Emplastrum Hydrargyri the most efficient mode of treatment. The surface may be cleaned before its application by being smeared with oil and well washed with soft soap. The plaster should be spread thickly on thin linen, and changed daily. Strong caustics are not to be recommended, and the results obtained by the application of superficial escharotics has not been encouraging. Painting with iodine has also been recommended. It excites a certain degree of inflammation after a few applications, in consequence of which the sebaceous plugs in the ducts of the follicles seem to become softened and discharged, thus causing temporary improvement. Linear scarification repeated at intervals of about a week has been found beneficial in some cases. In others the daily application of collodion has been of use.

Lupus Vulgaris or **Lupus : Pathological Appearances.**—This disease commences in the deep layer of the cutis vera. In its earliest stage circular accumulations of small round cells are seen displacing the bundles of fibrous tissue. The surrounding vessels are dilated, and new capillaries exist amongst the cells, and thus the nodule resembles in structure ordinary granulation-tissue. These circular masses of cells gradually increase in size, and by their pressure destroy the tissue of the true skin and thus approach the surface, until at last the papillary layer is implicated and the new growth is covered merely by the epithelium. During this process neighbouring groups of cells coalesce, and processes of cell infiltration extend along the vessels and surround the hair bulbs and follicles, so that in its fully developed stage a lupoid tubercle consists of an infiltration, and more or less complete destruction, of the normal tissue of the skin from the papillæ to the subcutaneous fat. On examining a section of a fully developed patch, non-vascular nodules composed of a giant cell, surrounded by larger "epithelioid" cells, and again by ordinary lymphoid or small round cells, will always be met with. These are identical in appearance with the nodules of tubercle, a fact which led Friedländer and Köster to regard lupus as a local tuberculosis of the skin.

This view has received confirmation from the observations of Cornil, Leloir, Koch, and others, who have demonstrated the presence of the tubercle-bacillus in the diseased tissues. The bacilli are very few in number and not easy to find. Koch states that he has never found more than one in a single giant-cell. Leloir found that the inoculation of the lupoid tissue into rabbits gave rise to general tuberculosis in about half the animals experimented on, and subsequently Koch obtained a pure cultivation of the bacillus from lupus, which was successfully inoculated on guinea-pigs. That lupus vulgaris is a local tuberculosis affecting the skin is therefore the generally received opinion at the present time.

After a patch of lupus has reached its full development, retrogressive changes take place. These may be of two kinds. In the first, some of the cells may become cloudy from fatty degeneration, break up, and be absorbed, while a development of cicatricial fibrous tissue takes place from the remainder. Thus, the process comes to an end without ulceration, and although the epithelial covering has been throughout intact, a scar results similar in appearance to that caused by a superficial burn. When the disease takes this course, it is described as *non-ulcerative lupus*, *lupus non exedens* or *lupus exfoliativus* (Kaposi). In the second form the fatty degeneration affects the whole of the cellular mass, which then softens; the cuticle covering it is thrown off and the disintegrated caseous matter is discharged, leaving an ulcer which may slowly extend. The disease is then known as *ulcerative lupus*, *lupus exedens* or *lupus exulcerans*. These two forms are therefore mere modifications of one process; the fate of the new growth, whether it is absorbed without ulceration or whether it softens and is discharged, being due to local or constitutional conditions, of the nature of which we have no definite knowledge.

Symptoms.—Lupus commences in the form of small nodules, buried in the skin. They are separate from each other, and arranged in groups, or sometimes in irregular circles. At first they form red or reddish-brown patches, from a line to a quarter of an inch in diameter, which are not raised above the surface. The nodules continue slowly to develop, till after some weeks they become slightly elevated, and covered by a fine branny epidermic desquamation. Several patches may coalesce, forming larger tubercles, and at the same time new patches appear, so that all stages of development may be observed at once in the same case. At this point the two forms of the disease diverge. In *Lupus non exedens*, the tubercle becomes paler in colour and gradually shrinks and disappears. The integument which has been affected by the disease may be in one of two states; it may either continue red, irritable, and branny, having the appearance of a thin cicatricial tissue, and in this way the greater part or the whole of the face may be affected; or it may leave a firm, white, smooth, and depressed cicatrix, exactly resembling that produced by a burn, along the margin of which the disease slowly spreads, in the form of an elevated ridge composed of soft bluish-white or reddish tubercles.

In *lupus exedens*, instead of disappearing, the tubercles become pale in colour and softened; the epithelial covering separates, and the disintegrated cheesy mass mixed with some pus is discharged, and drying on the surface forms a scab. This process may be accompanied by considerable inflammation of the skin surrounding the lupoid patches, with heat, swelling, and pain. When the scab separates, an ulcer is seen beneath. It is sharply defined, with slightly raised edges, and usually a smooth red surface which bleeds readily.

This sore may gradually extend both superficially and in depth, and when seated on the nose often leads to destruction of the alæ and columna. Lupus vulgaris seldom, however, spreads very deeply, although large areas of skin may be affected, and the most frightful deformity result.

Situation.—Lupus may occur on any part of the body, but it is far more commonly met with in the face than elsewhere, the nose and cheeks being the parts usually attacked. It may commence on mucous membranes, but most commonly reaches them by extension from the skin. It is, however, occasionally met with as a primary disease in the pharynx and larynx. It then usually assumes the ulcerative form, and may lead to extensive destruction of the mucous membrane.

Sex and Age.—Lupus vulgaris occurs more commonly in women than in men. It usually begins in early life, " rarely before the third year and almost never after puberty " (Kaposi).

Complications.—Beyond the deformity caused by the scars, the disease itself causes no serious consequences. As a rule it in no way affects the general health. Erysipelas not uncommonly attacks the diseased surface, and cases have been recorded in which epithelioma has arisen in the scars.

Causes.—Lupus is commonly said to occur in scrofulous subjects, but the great majority of cases present no other sign of the strumous diathesis. There is no evidence that it is ever directly or indirectly related to syphilis. Assuming that it is caused by the presence of the bacillus tuberculosis, we know practically nothing of the local conditions which predispose to the invasion of the cutis by the organism, beyond the fact that in rare cases it commences in a scar. It is very rarely associated with tubercle of the lungs, and shows practically no tendency to give rise to general tuberculosis.

Prognosis.—Lupus is characterized by its slow course, and its tendency to relapse after apparent arrest; it is, however, never directly fatal.

Diagnosis.—The diagnosis is not always easy, the disease being especially apt to be confounded with some forms of impetigo, with tertiary syphilitic ulcerations, with rodent ulcer and with cancer. From *impetigo* it may be distinguished by the absence of pustules, and of the thick gummy crusts characteristic of that affection, as well as by the less extent of surface implicated, and by its more chronic course. From *tertiary syphilitic ulcerations*, especially from the ulcerating tubercular syphilide or softening cutaneous gummata, it is often very difficult to distinguish it. The history of the disease, the age of the patient at the time of invasion, and the more rapid progress of the syphilitic affection will usually enable the Surgeon to make a correct diagnosis. From *squamous epithelioma*, it is distinguished with ease; in lupus the tubercles are numerous, and there are many centres of ulceration, the glands are seldom enlarged, and the disease commences in early life; in cancer the primary disease is single, the glands are early affected, the disease commences after middle life. In lupus the ulcer is flat, with sharply-cut edges; in cancer it is rugged and irregular, with hard, elevated and everted edges. The diagnosis from *rodent ulcer*, will be given with that disease.

Treatment.—The *constitutional treatment* of lupus was formerly considered of much importance. Cod-liver oil, the iodides of potassium, mercury, and arsenic, either alone or combined with various other drugs, have been credited with a curative, or at least a beneficial influence on the disease. At the present time when, by more extended clinical observation, simple scrofulous sores and tertiary syphilitic ulcerations have been clearly distinguished from true lupus, the efficacy of drugs in the treatment of the disease has been found to be much less than was once supposed. Kaposi states that no drug exerts any definite influence on the progress of the disease. Still, as lupus frequently occurs in patients who are in feeble health, anæmic or scrofulous, constitutional treatment must not be neglected; for, although drugs may exert no specific influence, it is evident that by improving the general health they will promote the healing of the ulcers. The diet should be carefully regulated and nutritious, and general hygienic conditions must be attended to.

It is on the *local treatment* that we have chiefly to rely, and the only efficient means are those by which the morbid growth is completely destroyed. In the milder form, non-ulcerative lupus, or lupus non exedens, an attempt may however be made to arrest the disease without actual destruction of the growth. For this purpose mercurial plaster, painting with tincture of iodine, or with a strong solution of nitrate of silver, and the application of zinc or carbonate of lead ointment have been sometimes found efficacious. Lotions containing glycerine are especially useful as they prevent the surface from becoming dry and harsh. If the disease be situated on the face, care must be taken to avoid exposure to cold winds, dust, &c. Volkmann recommends punctiform scarification by means of an instrument composed of several small blades set closely together. The object of this treatment is to obliterate the vessels and thus arrest the growth and promote absorption of the morbid products. Should these methods fail, the only hope of arrest consists in destroying the diseased tissue. If it be limited in extent, the patch may be excised, but not unfrequently the cicatrix becomes prominent and irregular from a fibroid growth resembling keloid. In lupus exedens destruction of the growth is the only treatment which holds out any prospect of success. In doing this the means adopted must be efficient. Feeble caustics only irritate the parts and aggravate the disease. The growth may be completely removed by excision, by scraping, by caustics, and by the actual cautery.

Excision is applicable only to small isolated patches in the early stage of the disease. When the affection is more extensive, scraping is of the greatest service. It is done by means of "sharp spoons" (Fig. 99, p. 254, Vol. I.). The brittle tissue of the growth is easily removed, and the sensation given by the denser healthy tissues beneath shows when the operation has been carried far enough. The bleeding is very free, but is easily arrested by pressure with dry cotton-wool. The small cavity may then be filled with a plug of wool soaked in a solution of perchloride of mercury (1 in 500) in order to destroy any bacilli that may have been left behind. In bad cases it is advisable to apply some caustic to the scraped surface to ensure the complete destruction of the growth. The caustics that have been used are various, solid nitrate of silver, chloride of zinc, acid nitrate of mercury, and fuming nitric acid have all been recommended, and are equally efficient. The actual cautery is easily controlled, and can often be used when other caustics are inapplicable. In most cases Paquelin's thermo-cautery is the best, but in deep cavities, as the mouth or nose, the galvanic cautery is more easily applied.

If when the case comes under observation there is considerable inflammation round the patch, it is better to subdue this by warm moist applications before adopting any of the above modes of treatment.

After the growth has been destroyed healthy granulations spring up, and the sore must be treated on ordinary principles. Vaseline and iodoform ointment often seems to promote the healthy healing of the raw surface.

However successful the treatment may appear at first, relapses are very common, but in a large number of cases as life advances the disease seems to become less acute, and finally ceases to reappear. The cicatrix that forms after lupus is healed is thin, and readily breaks down, giving way on exposure to cold, or on the occurrence of constitutional derangement. The patient should, therefore, for some length of time after recovery, be careful not to expose himself to any such influences. The scars often lead to great deformity, drawing down the eyelids, distorting the mouth, and sometimes closing the nostrils. Various plastic operations may be required to remedy these defects.

Rodent Ulcer, Noli-me-tangere, or Cancroid was formerly included under lupus exedens. It is a remarkable affection presenting the most unmistakeable local malignancy, but never giving rise to secondary disease, even in the neighbouring lymphatic glands. The disease consists essentially of a malignant growth of very feeble vitality and slight activity of development. This invades the surrounding structures and destroys them, and in its turn breaks down, disintegrates, and is thrown off, thus causing a progressive destruction of tissue. The disease is especially characterized by its slow progress, by its eroding nature, and by the impossibility of healing it by all ordinary methods of treatment. It is a disease of advanced age, seldom beginning before 45 or 50. Its duration is in any given case indefinite ; seldom less than five or six years, occasionally extending to twenty or thirty. It affects individuals of either sex indiscriminately ; and usually occurs in persons who are otherwise perfectly healthy. The health also is not influenced materially, if at all, by its long duration. I have seen persons, who have been victims to it for more than twenty years, in apparently robust health ; but it is often eventually fatal by gradual exhaustion from the discharge or by penetrating to the membrane of the brain, unless removed by operation.

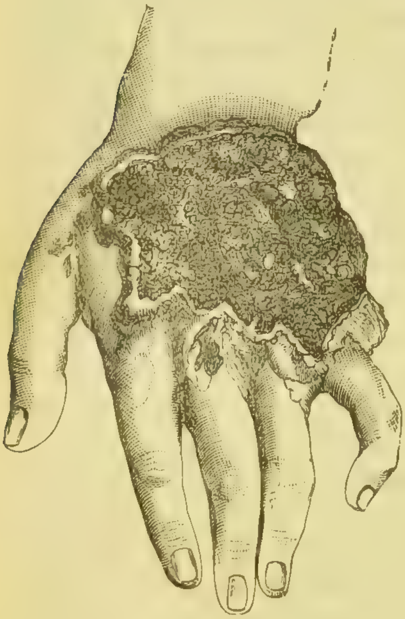

Fig. 420.—Rodent Ulcer of back of hand. Amputation.

It always commences in the skin, usually on healthy integument ; but occasionally it primarily affects a part which is the seat of some chronic change of structure, as a mole, a wart, or a scar. It may attack any part of the head, face, or extremities. The face is its seat of election, especially in the upper parts, such as the forehead, the side of the nose, the inner angle of the eye, or the temple. It spreads simply by continuity of tissue, never by disseminated local or secondary growths. It may invade all tissues ; the skin primarily, the cartilage of the ear, the alæ and septum of the nose, the parotid gland, the conjunctiva and the eye-ball. It eats away bone, and may penetrate to the dura mater, and invade the brain. It progresses, however, by preference superficially, not in depth; hence it is seldom attended by hæmorrhage, even in the more advanced stages. The neighbouring lymphatic glands do not become implicated, and secondary visceral growths are never met with.

Symptoms.—In whatever situation it begins, its first appearance is in the shape of a tubercle or hard pimple of a brownish-red colour. This ulcerates slowly; and then the disease extends. Moore, to whom we are indebted for a most lucid account of the affection, lays especial stress on its commencement in a hard wart, and its continued extension by a hard margin. This ulcerated tubercle becomes covered by a scab; but, as the process of destructive ulceration progresses, the sore becomes too large to be covered in this way, and an ulcer is left. This ulcer, which constitutes the disease, and is the "*Noli-me-tangere*" of the older authors, presents the following characters. It is always single, and spreads solely by continuity of tissue. It is depressed slightly below the surface, is of a pale pink colour, with a furrowed rather than a granulating surface, resembling by its furrowed smoothness an irregular layer of pink wax, and is usually painless, except where cicatrizing. Its edges are slightly raised, the degree varying in different cases and depending on the closeness with which the destruction of the new growth follows its development. In some cases the two follow each other so closely that the ulcer appears to be a simple loss of tissue, scarcely any thickening of edge being recognizable. Imperfect attempts at cicatrization form a peculiar feature of the ulcer. At one part of its margin it ceases to spread, and a thin blue line of epithelium begins to extend over the raw surface. This, however, never advances far; before long the spreading recommences at the edge of the apparently unaltered skin, and the thin layer of epithelium speedily disappears. This attempted cicatrization is never accompanied by any contraction of the sore. This want of contraction is a very characteristic feature of the disease. If half an eyelid is destroyed, the remaining half retains its normal position unaltered. Consequently signs of contraction may be taken during treatment to indicate that the growth has been successfully destroyed in part at least.

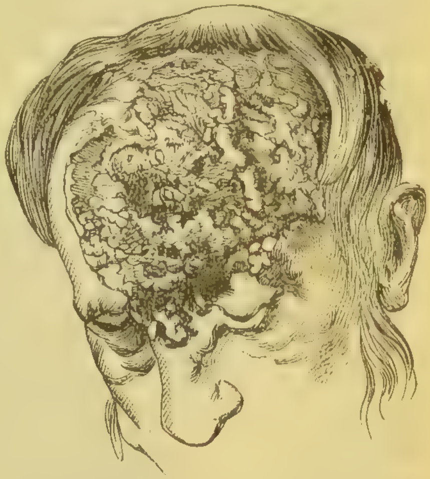
Fig. 421.—Rodent Ulcer: Perforation of Skull and exposure of Dura Mater.

The course of the disease is always progressive; more rapid in the skin, more slow in the bones and less vascular tissues, as those of a cartilaginous and fibroid character—the pinna of the ear, the sclerotic, and the septum of the nose, for instance. When it attacks bones, it penetrates deeply into their softer parts. Moore has noticed that the morbid growth in the advancing edge of the disease is always most clearly marked in cancellated bone—in the diploë, for instance. The soft parts immediately contiguous to the disease are perfectly healthy and uninfiltrated; and there is never, even after many years' duration, any sign of secondary affection of the lymphatic glands. Unless the progress of the disease be arrested by treatment, it is never interrupted, but will terminate in the death of the patient. This fatal termination may, however, be long delayed. The accompanying Fig. 421 is from a patient of mine who had suffered from the disease for nearly thirty years, but who was to all appearance in perfect health, although the skull was perforated, the dura mater exposed, and the pulsations of the brain distinctly visible.

Diagnosis.—The diagnosis has to be made from Epithelioma, Syphilis, and Lupus. The distinction from ordinary *epithelioma* is often at first difficult; but in the later stages the absence of glandular affection, the small amount of growth compared to the ulceration, and the prolonged course of the case, render the diagnosis easy. From *tertiary syphilis* it is clearly distinguished by the duration of the case; in syphilitic ulceration "the rate of destruction is measured by weeks; in rodent cancer, by years." There is also an absence of all other signs of constitutional syphilis. From ordinary *lupus* it is distinguished by the age and healthy constitutional state of the patient, by the singleness of the ulcer, and the absence of the pink, scaly, or œdematous skin frequently found around lupus. Lupus may cicatrize and cease at any time; rodent ulcer never does. Lupus never causes death; rodent ulcer is always eventually fatal, if unrelieved by treatment.

Pathology.—The microscopic characters of the infiltrating growth have been examined by Moore, Hulke, C. Warren, T. C. Fox, Thin and others.

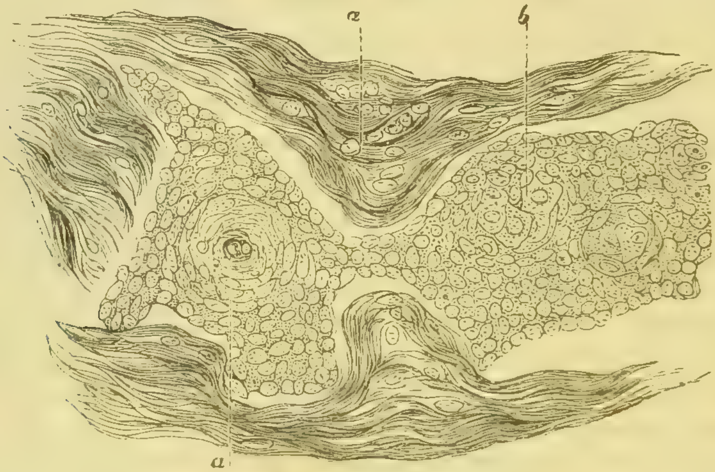

Fig. 422.—Vertical Section of Rodent Ulcer—*a*, Epidermic balls—*b*, Stroma (after C. Warren).

All are agreed that it is composed of groups or columns of cells of an epithelial type filling spaces in a very imperfectly developed connective tissue stroma. The epithelial cells are usually small and round, showing generally no tendency to become squamous or to form globes. Moore, Hulke and Warren have, however, observed that under certain conditions, especially when invading the diploë of the bones of the skull, the cells may become grouped in imperfect globes (Fig. 422), but these never have the hard corneous centre so commonly observed in true squamous carcinoma. The stroma is always infiltrated with small round cells, sometimes to such an extent as to resemble ordinary granulation-tissue. In other cases numerous spindle-shaped or oat-shaped cells may be present. The growth is therefore properly classed with the carcinomata, being composed of cells of an epithelial type advancing in processes or columns, in spaces formed by a vascular stroma. It infiltrates and destroys the original tissues of the affected part, and by degenerating and disintegrating produces a slowly advancing loss of substance. It infects adjoining parts, so that when removed by an incision carried through apparently healthy skin, a recurrence of the disease may follow. On these grounds Moore suggested for it the name of **Rodent Cancer.** It differs from other cancerous growths in infecting merely by continuity of tissue, never by the lymphatics or blood stream, thus presenting a lower degree of malignancy than any other variety of carcinoma.

Considerable difference of opinion still exists as to the point of origin of the growth. That it does not spring from the superficial epithelium is almost certain, as the cells show little or no tendency to assume the squamous form. Thin is of opinion that it arises from the spheroidal epithelium of the sweat-glands, while Fox believes it springs from the outer root-sheath of the hair.

Treatment.—In the treatment, constitutional remedies are of no use, and local means alone are to be relied on. These consist: 1, in excision of the diseased part; 2, in the application of caustics; 3, in a combination of these two methods.

1. Excision of the whole ulcer with a wide margin of apparently healthy skin is by far the best treatment whenever it is practicable, especially when it has not attained too great a size, and when it is situated on the cheek, eyelid, or forehead. The gap left may be filled in by one of the plastic operations which will be described when we come to speak of the Surgery of the Face.

2. If the patient objects to the use of the knife the ulcer may be best destroyed by the application of chloride of zinc paste to the whole of its surface. The best mode of applying this is to keep the chloride prepared for use by being mixed with two or three parts of flour. When wanted, a sufficient quantity of this powder should be made into a stiff paste, by the addition of a little water, and then spread over the surface to be attacked by it, in a layer of about the thickness of a wafer; this should be left on for two or three hours, and then removed, the sore being covered with a wet dressing until the greyish slough that has been produced has separated, when the caustic may be re-applied as often as necessary. Besides the chloride of zinc, various other caustics may be had recourse to, each of which possesses some peculiar advantages. Nitric acid is useful, if the action required is not to be very deep; for, as it hardens and coagulates the tissues to which it is applied, it does not extend so far as the chloride. In some cases very marked benefit has been obtained by the repeated application of Salicylic Collodion (Solvine). If the ulcer is situated on the face the extract of Indian hemp contained in the preparation may be omitted, so as to make it colourless. Further observation is required before the value of this mode of treatment can be determined, but as a few weeks' delay is of little moment in rodent ulcer, it may always be tried in the early stages. If its application is painful the surface may be previously numbed by means of cocaine.

3. When the ulcer has attained a large size, when it is complicated in its outline, and irregular in its depth, something may yet be done to prolong life and to relieve suffering, even if no cure be ultimately to be expected. Moore proved that, unless the brain be implicated, or some large vessel involved, treatment may at least arrest the rapidity of the growth. The method which he adopted was a combined use of the knife and of chloride of zinc. By these means he removed in some cases the whole of the affected parts, leaving a huge chasm in the face, and even in one case exposing the dura mater for a considerable extent over the roof of the orbit. The operations were

done on no regular plan, the incisions being directed solely by the shape of the growth, and no attempt being made to repair the deformity left. The results of these operations were, on the whole, favourable. Out of six cases three recovered, and three others received decided benefit, but were not permanently cured. In all the cases in which the chloride of zinc came into actual contact with the dura mater, epileptiform fits occurred, but only of a temporary character.

When the disease is so extensive, or so situated, that absolutely nothing in an operative way can be done, the Surgeon must content himself by covering the raw surface with lint soaked in glycerine and water, and protected by oiled silk. Iodoform, either dusted on or applied as an ointment, composed of one drachm of the powder to an ounce of vaseline to which a small quantity of eucalyptus oil may be added, will usually be found the best application.

CANCER OF THE SKIN may be either primary or secondary. **Primary Cancer,** if we exclude the Rodent Ulcer, always assumes the form of the Squamous Epithelioma. The structure and history of this has already been given. It is usually seated about the lips, face and scrotum, and at the orifices of the mucous canals. It may in rare cases arise from malignant transformation of an atheromatous cyst (p. 999, Vol. I.). Epithelial cancer may originate also in an old scar or ulcer. In this way it may occur upon almost any part of the body; I have seen it on the back, breast, fingers, hand, thigh, and sole of the foot. It then forms a foul ulcer, the floor of which is grey or sloughy, and often covered with large warty granulations and protuberant masses. The base is indurated, the edges raised and everted, and often papillary in structure (Fig. 423). The discharge is thin and scanty, and unless the sore is treated by antiseptic applications it becomes horribly offensive.

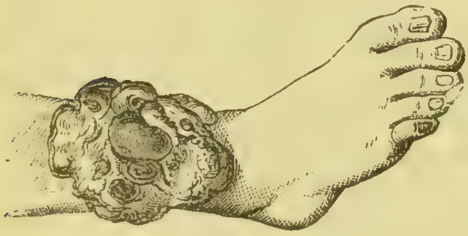

Fig. 423.—Cancerous Ulcer of the Leg.

Secondary Cancer of the Skin may arise from direct extension from a primary growth or from a secondary tumour. The most marked examples are commonly met with in cancer of the breast. In this disease, after the primary tumour has reached the surface, numerous smooth, elevated tubercles of a dusky red or brownish colour, may appear dotted in the skin for many inches around the part first implicated. Each of these is a small scirrhous cancer identical in structure with the primary growth in the mammary gland. In other cases, fortunately rare, the skin covering the side of the chest is widely infiltrated by the malignant growth. It becomes smooth, of a brownish-red colour, and hard and rigid, like a piece of leather, from which it has received the name of the "cancerous cuirass."

Sarcomata of the Skin.—Various forms of sarcoma are met with in the skin. *Spindle-celled* and *round-celled sarcoma* are seen here as in all other fibrous structures. Two forms, however, show a special predilection for the skin—the melanotic, and the alveolar.

Melanotic Sarcoma often commences in some pigmented spot, such as a mole. It forms a rounded tumour, smooth on the surface, and dark brown or black in colour. It is intensely malignant, and however early it may be removed, it is very apt to return both locally and in internal organs. If not removed it gradually increases and at last ulcerates, but before this takes place it often reaches a considerable size. I have met with two instances of late of this disease, one on the foot, the other on the hand, in ladies both above seventy years of age. Some time after removal in both cases, brownish black patches looking like stains with Indian ink appeared on the skin in the neighbourhood of the cicatrix. These gradually developed into new tumours. In one case hundreds of these formed up the leg, varying in size from a pea to a filbert. They slowly ulcerated and life was destroyed, probably by secondary growth in the viscera, after a period of about four years from the primary manifestation of the disease.

Alveolar Sarcoma of the skin is rare. Its structure and general character have been already described (p. 1036, Vol. I.). It commences as a hard lump in the cutis vera, which steadily increases in size until it may form a projection raised half an inch or more above the surface, and one inch or more in diameter. At first it is covered by the cuticle which is smooth and shining, but after a time this gives way in the centre of the tumour and an ulcer is formed which may gradually extend into the substance of the tumour. The edges of the sore are slightly raised and everted, and the surface is usually yellowish or grey and yields a thin discharge. In many cases numerous fresh growths spring up around the original tumours. Thus, in a case in University College Hospital, twenty or more such tumours, varying in size from a pea to a walnut, were scattered over the leg below the knee. They grow slowly as a rule, and give little pain. If not removed by operation, they ultimately prove fatal by gradual extension of the local growth with wide spreading ulceration, but more commonly by the formation of secondary tumours in the viscera. It is probably this tumour that was described by Scarpa as the "scirrhous wart," as from its hardness and the local and general malignancy it usually manifests, it closely resembles scirrhous cancer.

The **Treatment of a Malignant Tumour of the Skin,** whether a cancer or a sarcoma, consists in its excision or in amputation of the limb affected. Its removal by excision should be effected as soon as its nature is recognized : provided it be of such a size, and so situated, that it can be freely removed with a sufficient stratum of subjacent healthy parts, and a wide border of surrounding skin. Should this be impossible, and the growth be situated on a limb, amputation must be performed. In such circumstances the limb may be removed at no great distance above the disease ; it not being necessary, as in cases of malignant tumours of the bones, to allow a joint to intervene between the seat of operation and the growth.

SIMPLE TUMOURS OF THE SKIN.—

Fibroma.—Circumscribed fibrous tumours are occasionally met with in the skin, but are not common.

Keloid is a fibroid growth not encapsuled, but fusing with the healthy skin at its edges. It forms a flat tumour, raised about a line above the surrounding healthy skin. It is oval, rounded or irregular, and branching or radiating in form. The surface is smooth, and white or pink in tint. It is firm and elastic in consistence. It arises without known cause and most frequently upon the trunk or extremities in persons otherwise healthy. It is seldom painful, but may give rise to itching and burning sensations. It extends slowly, and although covering a wider area sometimes seems to have undergone a process of contraction like a scar, the surrounding skin being drawn in and wrinkled or puckered. After reaching a certain size it ceases to grow. It has no tendency to ulcerate or to degenerative changes. The *treatment* is merely to allay uneasy sensations by sedative applications. If excised, it almost certainly returns in the scar.

Closely allied to true keloid are those fibroid growths that have a tendency to sprout up in scars, constituting **False Keloid.** It was described also by Sir Cæsar Hawkins under **Warty Tumours of Cicatrices.**

This morbid condition appears to be simply an abnormal increase in the activity of the development of the cicatricial tissue, which springs up with great luxuriance. These growths are especially apt to follow the irregular cicatrization of burns, more particularly in children. I have, however, seen them in the adult, occasioned both in this way and by the irritation of a blister. The warty cicatricial tissue develops chiefly on the chest and neck, and is commonly attended by much itching and tingling, often of a most distressing character. It is very vascular, bleeding freely when incised. The *Treatment* of these growths is not satisfactory. As a rule, they may safely be let alone. If they cause any annoyance the only treatment is to remove them by the knife if they are so situated as to make this possible, but most commonly the new scar assumes the same unhealthy condition.

Morphœa or Circumscribed Scleroderma is another condition in some respects resembling keloid. In this disease the skin is thickened and indurated in patches or bands most commonly upon the trunk, as between the breasts. The patches are usually slightly raised above the surface, smooth, and sometimes of ivory-like whiteness. Atrophic changes may occur in the diseased skin, causing some contraction. The disease is apparently of a chronic inflammatory character, and its cause is unknown. Treatment can do little, if anything, for it, but spontaneous recovery may occur.

The disease known as **Molluscum Fibrosum,** in which enormous pendulous tumours composed of hypertrophied skin and subcutaneous tissue form on the buttocks, thighs, or other parts, has already been described (p. 1012, Vol. I.).

Osteomata of the Skin have been described. They are always atheromatous cysts, the walls of which have undergone calcification, and occasionally true ossification in parts (p. 1000, Vol. I.).

Adenomata of the Skin arising both from the sweat-glands and the sebaceous follicles have been occasionally met with, but are very rare. When arising in connection with the sebaceous follicles they form lobulated masses of some size, which after growing for many years may ulcerate and resemble epithelioma in appearance. On microscopic examination, they are found to be composed of a structure resembling a number of greatly enlarged follicles bound together by a vascular connective tissue.

In hypertrophy of the sweat-glands or *adenoma sudoriparum* the growth lies just beneath the corium, and may form a firm flat circular mass from a quarter to half an inch in thickness and sometimes reaching one inch in diameter. The skin is slightly raised over it and may be marked by the openings of the dilated glands. Microscopic examination shows the tumour to be composed of convoluted tubes, exactly resembling normal sweat-glands, but usually of greater diameter, between which is a small amount of new fibrous tissue. The fat is pushed on one side by the growth, but not invaded by it. It causes no pain, and has little tendency to ulcerate. It seems probable, however, that in some cases the epithelium may proliferate more rapidly, burst through the membrana propria of the tubules and invade the surrounding tissues. In this way, according to Klebs, a simple tubular adenoma of the sweat-glands merges into rodent cancer.

Atheromatous and other Cysts have already been described (p. 999 *et seq.*, Vol. I.), and **Nævi** will be described in a subsequent chapter with diseases of the blood-vessels.

Moles are pigmented patches of variable size in the skin, and always congenital. They are often raised above the surface of the surrounding skin and covered with hair, sometimes long and coarse. They cannot be properly classed as tumours, as they show no tendency to grow out of proportion to the rest of the body. In later life, however, a mole not unfrequently forms the starting point of a tumour. It may gradually increase in size, becoming more and more prominent, and sometimes pedunculated. It may thus form a tumour, usually lobulated or papillary, and more or less darkly pigmented. Finally, from the friction of the clothes it may ulcerate and become very troublesome. A mole also not uncommonly forms the seat of origin of a sarcoma, or more rarely of a squamous epithelioma. A mole requires no treatment unless it become affected by one of the complications above mentioned, when it must be at once excised. The Surgeon is often consulted as to the possibility of removing a disfiguring mole from the face. There is no method by which this can be done without leaving a scar in its place, but if the patient prefer this to the pigmented patch, the mole may be destroyed by caustics, or excised with the knife.

Papillomata of the Skin, or **Warts**, consist of elongated papillæ, covered by strata of thickened and hardened cuticle, usually situated about the hands and face, and chiefly affecting young people ; they appear in many cases to be simple overgrowths of the cutaneous structures, coming and going without any evident cause. In other cases they are more permanent, becoming hardened and dark in colour, and continuing perhaps through life.

The *Treatment* of warts is sufficiently simple. They may be readily destroyed by the application of caustics or astringents ; among the most useful of these, I have found the concentrated acetic acid and the tincture of the sesquichloride of iron. Moles usually disappear rapidly under the influence of salicylic collodion. This is composed of salicylic acid, 100 grains, dissolved in flexible collodion ($\frac{3}{4}$ strength). The salicylic acid seems to exert a peculiar solvent action on the epidermis. If it causes any pain, extract of Indian hemp may be added, as in the preparation known as "Solvine," or collodium callosum. It contains 60 grains of salicylic acid, and 8 grains of extract of Indian hemp to 1 ounce of flexible collodion ($\frac{3}{4}$ strength).

Corns consist of thickened masses of epithelium accumulated on those points on which undue pressure or friction has been exercised. They result from an overgrowth of the epithelium, consequent upon the abnormal stimulation to which the part is exposed. This is accompanied by some enlargement of the papillæ. The mass of epithelium is hard, dry, and scaly. In the central parts it may lead to some atrophy of the papillæ from pressure, and consequently the horny mass assumes a conical form, with its apex downwards, pressing on the sensitive cutis beneath, and thus causing considerable pain. When the corn is situated in places where the secretions of the skin accumulate and keep it moist, as between the toes, the excessive epithelium forms a soft pulpy mass which is easily removed, and the enlargement of the papillæ is then very evident.

Under old and very thickened corns, a small bursa is usually found, in which pus is occasionally formed. The accumulation of a small drop of matter under the thickened cuticle, which prevents its escape, gives rise to the most intense agony, and may cause œdema and redness extending from the toe to the foot, and sometimes up the leg. There is a special form of warty corn, met with only on the sole of the foot, which may become the source of the greatest possible pain and inconvenience to the patient, altogether preventing his walking. It is usually of small size and circular in shape, the neighbouring cuticle being always considerably thickened. It is extremely sensitive to the touch, the patient shrinking when it is pressed upon, as if an exposed nerve had been injured. On slicing it down with a scalpel, it will be found to be composed of soft, tough, and white epidermis, arranged in tufts or small columns, in the centre of each of which a minute black dot is perceptible. Each tuft appears to be an elongated and thickened papilla, and the black speck is a small point of coagulated blood which has been effused into it. The whole group of enlarged papillæ is surrounded by a kind of wall of thickened epithelium. This condition is popularly termed "a black corn."

The *Treatment* of ordinary corns consists in shaving or rasping them down so as to prevent the deep layers of cuticle, retained by the indurated superficial ones, from giving rise to pain by pressure on the papillæ of the cutis. The cuticle may be previously softened by dressing the toe with wet lint covered with gutta-percha tissue. The thickened epidermis may also be removed by the application of one of the numerous popular remedies known as "corn solvents." The best of them is that mentioned above under the name of Solvine. It must be applied daily for a few days, at the end of which time the thickened epidermis will peel off in a cake, leaving almost normal skin beneath. Relief may be afforded also by removing all pressure from bearing upon the corn, by attention to the shape of the shoe, and by wearing a piece of soft leather or amadou, having a hole cut in the centre into which the corn projects. A soft corn between the toes is best treated as follows: clear away the sodden epithelium with soap and water; wash the interdigital space with tincture of belladonna and let it dry; then apply "solvine" to the corn. The toes may be separated by means of a small piece of cotton-wool moistened with tincture of belladonna, which will effectually check perspiration. Sometimes the belladonna causes eczema; its use must then be at once abandoned, and the toes washed twice a day with a concentrated solution of boracic acid. Caustics should never be applied to ordinary corns; injurious consequences being often produced by these agents, especially in elderly people, in whom fatal gangrenous inflammation may be excited by their action. The only exception to this rule is in the case of the painful papillated corn of the sole of the foot, in which no other treatment is of any use. I have found the application of either fuming nitric acid or potassa fusa, so as to destroy it thoroughly, to be the best and speediest remedy; and as this corn always occurs in young people no danger attends their use.

If a corn suppurate, it must be softened by water dressing and shaved down, and the drop of pus let out by puncture with a lancet, when immediate relief from pain will result. If the pus is not thus let out it is unable to point through the indurated cuticle, and may burrow beneath the skin for some distance before finding an exit. In such case a troublesome sinus is left which can sometimes be closed by the injection of stimulating lotions, but more often laying it open is the only efficient treatment.

Perforating Ulcer of the Foot.—This, though not in reality a disease of the skin, is perhaps most conveniently considered here. This disease seems usually to commence by a corn situated on the sole of the foot opposite the head of one of the metatarsal bones; usually the first. This, in some cases apparently as the result of an injury, becomes inflamed and suppurates, and a sinus is left opening through the thickened cuticle. If a probe be passed into this it will be found to lead to dry and spongy bare bone on one of the phalangeal or metatarsal bones. The discharge is scanty and scarcely purulent. The ulceration may extend, forming a sore an inch or more in diameter. This is covered by feeble or unhealthy granulations. The disease is painless, and on further examination the foot will be found to be more or less widely anæsthetic. The anæsthesia may extend up the leg, but it is never associated with motor paralysis. The tendency of the disease is slowly to extend, causing further destruction of the bones and possibly completely perforating the foot. The foot is cold, and in most cases is prone to sweat profusely, the perspiration being very offensive. Both feet may be affected, and a similar disease has been seen in the hand.

Michaud, Sonnenburg, Duplay, and more lately Savory and Butlin, have pointed out that the disease is associated in many cases with thickening of the endoneurium and atrophy of the fibres of the nerves leading to the affected spot. Savory and Butlin have brought forward evidence to show also that the sensory fibres are chiefly, if not solely, affected. Similar ulcerations are met with in some cases of locomotor ataxy, and more rarely in connection with some peculiar cases of spina bifida (see Spina Bifida). It may therefore be concluded that the primary cause of the disease is impairment of nutrition consequent upon degenerative changes taking place either in the nerves leading to the affected parts or in that portion of the sensory columns of the cord that is in communication with the foot.

The *Treatment* consists in amputation of the affected part. In order that this operation may be effective it should be done above the area of anæsthesia in the foot or leg. In some cases the sore can be made to heal by thorough scraping followed by efficient antiseptic treatment, but relapse almost inevitably takes place, rendering amputation necessary at last.

CHAPTER XXXVIII.

DISEASES OF THE NERVOUS SYSTEM.

NEURITIS.

Inflammation of the Nerves, or rather of the Sheath, is not of very unfrequent occurrence, being usually the result of rheumatism, of wounds, or of strains. When Neuritis is rheumatic, it affects principally the nerves of the face and the lower extremity.

Symptoms.—These consist of tenderness on pressure along the course of the nerve, and severe continuous pains running down its trunk and ramifying along its branches, with occasional violent exacerbations, especially on moving or touching the part, and at night. In very rare cases the disease may assume an acute form, with some swelling along the course of the nerve, and slight pyrexia. Ordinarily the affection is chronic. It is one of the causes of neuralgia. Should the opportunity occur of examining the nerve after death in acute cases, the sheath will be found injected and swollen from inflammatory exudation. In chronic cases the peri- and epi-neurium may be found indurated and increased in quantity, the nerve-fibres being more or less compressed by the new fibroid tissue. Traumatic neuritis has been already fully described (Vol. I., p. 495).

Treatment.—In acute cases this consists in the application of leeches, according to the situation, and poppy or belladonna fomentations. In chronic cases blistering or the application of mustard-plasters along the line of the nerve usually gives relief. The part in which the affected nerve is situated must if possible be kept at perfect rest. When the affection is rheumatic, salicylate of soda is frequently of great use ; in some cases the acetous extract of colchicum is the best remedy ; when it is more chronic, and the pain is chiefly nocturnal, iodide of potassium may advantageously be given.

SCIATICA.

The characteristic feature of sciatica is pain of a neuralgic character in the course of the great sciatic nerve. The affection is believed in the great majority of cases to be due to chronic rheumatic inflammation of the sheath of the nerve, and some thickening of the epineurium has been recognized after death in a few instances. In other cases pain of a similar character may be the result of pressure on the nerve by tumours in the pelvis or gluteal region, or occasionally from affection of the cord or disease of the spine in the lower lumbar or sacral region. Sciatica is most common in young adults, and frequently arises from exposure to cold or damp.

The *Symptoms* of sciatica are pain in the buttock, back of the thigh, and the leg below the knee. The pain may amount merely to uneasiness, or be intense and paroxysmal. It is usually aggravated by movement, often to such an extent as to render locomotion impossible. When the pain extends to the foot it is felt chiefly on the outer side, the inner being supplied by the long saphenous nerve from the lumbar plexus. By pressing with the point of the finger, tenderness will be found in the course of the nerve. This is most marked in the hollow between the trochanter and the tuberosity of the ischium, and down the back of the thigh. The external popliteal nerve is also sometimes acutely tender where it winds round the upper end of the fibula. When the patient is lying on his back, if the limb be raised with the knee extended, acute pain is felt in the buttock as soon as the sciatic nerve becomes tense. If now the knee be flexed so as to relax the nerve, flexion of the hip can be carried considerably further without pain. Numbness in some of the parts supplied by the nerve is not uncommon, especially on the outer side of the foot. Motor paralysis never results from simple sciatica, but there may be some weakness or even wasting of the limb from want of use. The affection is very chronic, often lasting many weeks or even months.

The **Diagnosis** of sciatica is made by attention to the above symptoms. It is most frequently confounded with strumous disease or chronic rheumatic arthritis of the hip. The distinction is in most cases easily made by observing that the movements of the hip-joint are free and unaccompanied by pain, unless flexion is carried to such an extent as to render the nerve tense. In rheumatoid arthritis the grating felt in the joint on movement will usually indicate the nature of the disease ; with the " lightning pains " of locomotor ataxy it must not be confounded. In all cases of sciatica a careful examination of the buttock must be made for a tumour in that region ; the lower part of the spine must be examined for signs of caries, and the finger might be passed into the rectum to feel for a pelvic tumour, as in these conditions local treatment directed to the course of the nerve could be of but little use.

Treatment.—The constitutional treatment already described for rheumatic neuritis must be adopted. The limb must be wrapped in flannel. Counter-irritation along the line of the nerve in the early stages by mustard-plasters, and later on by blisters is most useful. The application of a long strip of capsicum-rubber plaster along the line of the nerve often produces a good effect. Hot baths usually give considerable relief. Stimulating applications, as the ammonia or compound camphor liniment, may be of use ; and sedatives, as the opium or belladonna liniment, may ease the pain, but they do little to cure. Hypodermic injection of cocaine has given relief in some cases. Hypodermic injections of morphia should be resorted to only when the patient is suffering from want of sleep due to the pain. They exert no curative influence.

If the constitutional treatment and external applications fail, as they very frequently do, two modes of treatment may be adopted, acupuncture and nerve-stretching.

Acupuncture is thus performed. The patient is laid on his face, and the tender points of the nerve found by pressure. Long fine needles are then thrust in so as if possible to puncture the nerve. When the needle touches the nerve the patient complains of a sudden pain down the thigh. The number of the needles used should not exceed six. They may be left in for a few minutes. This treatment sometimes gives permanent relief.

Our last resource is, however, **Stretching the Sciatic Nerve.** (See Vol. I., p. 497). This operation has been more successful in sciatica than in any other painful affection for which it has been undertaken. Nocht has collected 24 cases: of these 16 were quickly, 5 slowly, relieved, in 2 the operation failed, and 1 died. Marshall finds that of 9 cases which occurred in University College Hospital, 4 were decidedly improved, 4 relieved, and 1 failed.

The operation is thus performed. The patient is laid upon his face and a vertical incision, about three inches in length, is made a little above the middle of the back of the thigh. The deep fascia is opened and the contiguous borders of the semi-tendinosus and biceps are separated with the finger. The wound being now held open by copper spatulæ, the sciatic nerve comes into view and is raised out of the wound by passing the finger beneath it, the knee being flexed to relieve it from tension. It is then pulled forcibly in both directions for about five minutes. Marshall has demonstrated that any force which can be applied while holding the nerve between the finger and thumb may safely be used. The experiments of Johnson, Trombetta, Ceccherelli, and others, have shown that the breaking strain of a healthy sciatic nerve is never under eighty pounds. The wound after the operation must be carefully drained and dressed by some antiseptic method, and it is better to apply an anterior splint for a week or ten days.

Some Surgeons prefer exposing the nerve at a higher point, below the lower border of the gluteus maximus. If the operation be performed at this point. the whole of the ham-string muscles together must be drawn to the inner side of the wound, and the nerve sought for external to them. If necessary, the lower fibres of the gluteus may be divided. There is no particular advantage in this mode of operating, and the resulting wound is deeper and more difficult to treat owing to its situation.

Trombetta and Billroth have suggested stretching the nerve by means of forcible flexion of the hip with the knee extended and the foot flexed. That a very great strain can be put upon the nerve in this way is evident, and the method might very well be tried before proceeding to the more severe operation just described. It is best done by flexing the thigh fully on to the abdomen with the knee bent, and then, while the thigh is fixed, extending the leg.

The conductivity of the sciatic nerve is not affected at all, or only to a very slight degree, by force used in the operation. It has been suggested that it acts by breaking down adhesions either amongst the fibres or between the sheath and surrounding structures. Marshall believes it acts by stretching or even rupturing the small nervi nervorum ramifying in the neurilemma and in the epineurium, which must be more or less implicated and pressed upon by any inflammatory growth or exudation in chronic neuritis.

NEURALGIA.

Neuralgia frequently occurs in surgical practice, either complicating other diseases, or as a distinct affection simulating closely various organic lesions, more especially of joints and bones.

Symptoms.—The pain in neuralgia is the essential symptom. It may be of two kinds; either following anatomically the course of a nerve and the distribution of its filaments; or affecting a considerable portion of the surface without reference to any special nerve. It is of all degrees of severity, sometimes moderate, sometimes unbearable, even by those who possess the greatest fortitude ; when severe, it usually comes on suddenly, with a kind of shock, and continues as a sharp, darting, or tearing sensation, coursing along the trunk or ramifications of the affected nerve, the distribution of which may often be distinctly indicated by the direction the pain takes. It is often accompanied by other sensations, such as a tickling, smarting, or creeping feeling on the affected surface ; it is in some instances relieved by pressure, in others increased by the slightest touch or movement of the part. Occasionally there is spasm in the muscles supplied by the affected nerve ; in other cases, there are heat and redness of the surface, with increased secretion from the neighbouring organs, as a flow of saliva or tears when the nerves of the jaw or eye are implicated. The duration of an attack may vary from a few moments to many days or months. The pain is most commonly intermittent or remittent ; it is often irregularly so, but in some instances the periodicity is well marked.

Situations.—This disease may affect almost any part of the body ; it is most commonly seated distinctly in the trunk and branches of a nerve. The divisions of the fifth pair are the most frequent seat of neuralgia ; the pain may extend to all the branches of this nerve on one side of the head and face, but more commonly it is confined to one of its principal divisions, such as the infra-orbital, which is especially liable to be affected ; in many instances it is seated in the temporal and dental nerves. Not unfrequently some of the terminal twigs alone of one of these nerves become the seat of intense pain ; thus occasionally the affection is found limited to a patch on the cheek, brow, or temple, from which it scarcely ever shifts. The posterior branches of the dorsal spinal nerves, and the intercostals, are also very commonly affected, though not to the same extent as the fifth pair. In other cases the whole of an organ, or part, becomes the seat of neuralgia, though no one nerve may appear to be distinctly implicated ; thus the testes, the breast, the uterine organs, or one of the larger joints, as the hip or knee, are occasionally the seats of severe suffering of this kind. Extreme cutaneous sensibility is a marked feature in some cases : the patient wincing and suffering severely whenever the skin is pinched or touched, however lightly.

Causes.—The causes of this painful affection are very various ; they may be constitutional or local. It seldom occurs in strong and healthy individuals, but is almost invariably associated with want of power, unless it be occasioned by some local mechanical cause. *Depressing influences* of all kinds are especially apt to produce it ; thus, debilitating diseases, mental depression, and particularly exposure to malaria, are common occasioning causes ; those forms of the disease that arise from malarial influences, or from exposure to simple cold and wet, usually assume a very intermitting or periodical character, and are commonly seated in the nerves of the head. The *hysterical temperament* very frequently disposes to the spinal and articular forms of neuralgia. There is no constitutional condition with which neuralgia is more frequently associated than with anæmia ; hence its frequency in females. As Romberg somewhat poetically says, "Neuralgia is the prayer of the nerve for healthy blood." Various sources of *peripheral irritation*, as loaded bowels, the irritation of worms, carious teeth, uterine disease, and calculus, may be recognized as producing some of the more obscure varieties of the disease.

Neuralgia may arise also from any compression exercised upon the trunk of a nerve ; and in this way, indeed, some of the more intractable forms of the affection have their origin. Thus, thickening of the fibrous sheath, the pressure of a tumour of any kind, or of a piece of dead bone, may give rise to the most intense pain in the part supplied by the irritated nerve ; and it is not improbable that, in many of the cases of neuralgia in the branches of the fifth nerve, pain may be owing to periosteal inflammation, or to some other disease of the osseous canals through which the divisions of the nerve pass.

Diagnosis.—The diagnosis of neuralgia, though usually made without any difficulty, is in some cases a little embarrassing, as the pain may occasionally simulate that of organic disease or inflammation of the part. From *organic disease* of the part that is the seat of suffering, such as the hip, the knee, the testis, or the breast, this disease may usually be distinguished by the co-existence of heightened cutaneous sensibility, the existence of the hysterical temperament, and the absence of the other signs that would accompany lesion of structure in the part affected. From *inflammation* the diagnosis is usually sufficiently easy, by attending to the intermittent character of the neuralgic pain, to its occurrence in hysterical subjects, and to the absence of the constitutional symptoms of inflammation. But occasionally, when local inflammatory irritation is conjoined with the neuralgia, the diagnosis is difficult. Here the presence of cutaneous hyperæsthesia and the relief of the pain by firm pressure will indicate neuralgia ; whereas, in inflammation, there is no tenderness of surface, but the suffering is aggravated by deep pressure.

Treatment.—The treatment of neuralgia must have reference to its cause, and will be successful or not according as this may be more or less readily removed. So long as the conditions that primarily occasion the disease persist, the pain is likely to continue : and if these conditions be irremovable, the disease may be looked upon as necessarily incurable, though the suffering may be alleviated by appropriate means. When it arises from any central nervous affection, there may be fear of the ultimate occurrence of disease of a more serious type, such as epilepsy, insanity, &c.

When it occurs as the consequence of anæmia, or in the hysterical temperament, the administration of the more stimulating and stronger preparations of iron, such as the sulphate or the perchloride, or the mistura ferri composita, either alone or in combination with quinine, with attention to the state of the bowels and of the uterine functions, and a regimen calculated to improve the general health, such as sea-bathing, the cold douche or cold sponging, will be of essential service. In some of these cases the combinations of zinc, especially the valerianate, with the fœtid gums, will remove the disease when iron does not influence it much. When the neuralgia is distinctly periodical, quinine in full doses, or the liquor arsenicalis, will usually effect a speedy cure. When it is rheumatic, occurring in debilitated subjects, and attended by distinct nocturnal exacerbations of pain, no remedy has so great an effect upon it as the iodide of potassium, especially when administered in combination with quinine. In the more severe and protracted forms of the disease, relief may be occasionally given by attention to the state of the liver and digestive organs, by a course of some of the more purgative mineral waters, and by the occasional administration of aloetics, followed by tonic remedies. In some cases, especially when the disease affects the branches of the fifth nerve, croton chloral hydrate in doses of 1½ grain to 5 grains, may give relief.

Local applications of a sedative kind, such as chloroform, belladonna, aconite, opium, &c., are often useful adjuncts to constitutional treatment. Solid menthol rubbed on the part sometimes relieves the pain in neuralgia of the face. Chloral and camphor rubbed together in equal parts form a liquid which may be painted over the painful area with benefit in many cases. By far the readiest mode of affording relief locally is the hypodermic injection of from one-sixth to a quarter of a grain of morphia. More than this it is unsafe to begin with; but the quantity may be enormously increased. I have had a patient who, to relieve the pains attending cancer of the rectum and anus, required no less than six grains to be injected every twelfth hour. In some cases a single injection has cured neuralgia which has resisted all other means. Hypodermic injections of cocaine may in some cases give temporary ease. Relief may often be obtained by the use of electricity in the form of the continuous current. The positive sponge must be applied to some convenient place near the seat of pain, while the neuralgic spot is gently rubbed with the negative until the skin is reddened. In exceptional cases the relief is permanent. Granville has in some cases obtained permanent relief by rapid light percussion by means of an instrument called a "percuteur."

In many cases all these means, however, are unfortunately unavailing, and the sufferer is doomed to an existence of almost constant pain, except at times when the disease appears to cease of itself, or has its intensity blunted by the administration of the more powerful sedatives, such as morphia hypodermically, or veratria, aconite, or atropine externally. In these distressing cases the sufferer is ready to grasp at any means of relief that is held out to him: and **stretching of the affected nerve** is now frequently undertaken in the hope of relieving, if not completely removing the affection. This operation has already been described (Vol. I., p. 497). It was there pointed out that the effect produced varies considerably according to the size of the nerve operated on. In small nerves, such as those of the face, the conductivity of the nerve is abolished as completely as if it had been divided, but as its continuity is not interrupted, repair always takes place, and after a time its function is restored. In the larger nerves, even when considerable force is used, the conductivity is not completely abolished, although it may be modified for a time. It is only when great force is used that the breaking up of the medullary sheath observed by Leuterman and Horsley takes place. We have seen that in sciatica, in which the disease is seated in the actual trunk of the nerve, great benefit is usually derived from nerve-stretching, and probably the same result may be hoped for when a similar condition exists in other nerves. In the majority of cases of neuralgia, however, the cause is either some peripheral irritation of the terminal branches or some central disease, and in these but little is to be expected from the operation. In the former case there might be temporary relief until repair of the nerve was accomplished; and in the latter, although experience has shown that there may be some improvement, this is only of a temporary character.

When stretching has failed, **section of the affected nerve** is not unfrequently recommended as a last chance of the removal of the disease. Simple section of the smaller nerves is now replaced by stretching, which, as has just been stated, temporarily abolishes their conductivity. Division is undertaken with the intention of permanently destroying the continuity of the nerve, and to ensure this about a third or half an inch of the trunk must be cut away. As with stretching, however, it is clear that the operation, though occasionally productive of temporary relief, cannot in most cases be expected to benefit the patient permanently; for by it the cause of the neuralgia is not removed, and it can consequently be of service only when the pain is peripheral, occasioned by some local irritation existing between the part cut and the terminal branches of the nerve. If the neuralgia depend on any central cause, or on local irritation existing higher up than the point divided, the operation must eventually be useless. Thus, if the source of irritation exist in the terminal branches of the infra-orbital nerve, the division of this trunk might be useful; but if the pain be occasioned by any pressure to which this nerve may be subjected in its passage through its canal by a carious state of the bones, or by disease of the periosteum, it would be unavailing; though it is remarkable that it not unfrequently happens that there is after these operations a temporary cessation of pain for a few weeks or months. In some of these cases, however, the pain shifts its seat from the branch operated on to another division of the same trunk; thus, if the infra-orbital have been divided, the inferior dental or submental nerve becomes the seat of pain. Or this may ascend, as it were, to the point at which the nerve was divided; thus, after amputation for neuralgia of the knee, the pain may return in the stump, and again when this is removed a second or even third time.

Facial Neuralgia is the most common form of the disease. It may affect any one of the branches of the fifth, or in extreme cases almost every part at the same time. The various divisions of this nerve have, therefore, been most frequently stretched or divided for neuralgia, and it is necessary briefly to describe the operative procedure required in the case of each nerve.

First or **Ophthalmic Division of the Fifth.**—It is evident that the frontal branch of this nerve is the only part that can be either stretched or divided. The frontal divides about the middle of the orbit into the supra-trochlear and supra-orbital branches. The supra-trochlear is too small, and, as a rule, too much broken up into branches to be isolated and stretched. The supra-orbital, on the other hand, leaves the orbit usually as a single trunk, and can be isolated without difficulty. The position of the nerve is recognized by feeling for the supra-orbital notch, through which it passes. The nerve may be stretched subcutaneously by making a small puncture with a tenotome about a quarter of an inch on one side of the notch. A blunt hook is inserted through this and forcibly scraped along the bone until its point has passed the line of the nerve. The skin of the forehead must be pulled upwards so as to make it tense, and there will then be no difficulty in ascertaining by the sense of resistance whether the nerve has been hooked or not. If it be felt upon the hook, the skin of the forehead being pulled forcibly upwards, the nerve may be firmly stretched.

Section of the supra-trochlear and supra-orbital branches can be done subcutaneously by inserting a tenotome about half an inch external to the line of the latter nerve, and passing it inwards nearly to the root of the nose. In withdrawing it a firm incision must be made along the margin of the orbit, keeping slightly to the frontal side in order to avoid wounding the palpebral ligament, which might be followed by considerable extravasation of blood into the loose tissue of the orbit.

To expose the supra-orbital nerve, the skin of the forehead must be drawn up and the eyelid down, and a curved incision about three-quarters of an inch in length must be made parallel to the eyebrow and a little below it, the centre of the wound being opposite the notch. The fibres of the orbicularis palpebrarum may then be separated by a blunt instrument, and the nerve exposed as it leaves the orbit lying closely upon the bone. It may then be stretched, or a piece cut out as desired. Care must be taken not to wound the palpebral ligament, otherwise blood may be extravasated into the orbit and suppuration follow.

The **Second** or **Superior Maxillary Branch of the Fifth.**—This nerve, after crossing the spheno-maxillary fossa, enters a canal in the floor of the orbit, and appears on the face through the infra-orbital foramen. The nerve has been divided as it leaves the foramen, in the canal, and in the spheno-maxillary fossa. The situation of the infra-orbital foramen is found by drawing a line from the supra-orbital notch to the interval between the two bicuspid teeth of the lower jaw. This line crosses the infra-orbital foramen, and if prolonged will show the position also of the mental foramen. The infra-orbital foramen is situated about half an inch below the lower margin of the orbit. The nerve lies rather deeply, but can be stretched subcutaneously in the same way as the supra-orbital, by puncturing the skin with a tenotome and grappling for the nerve with a blunt hook, the point of which is made to scrape along the bone below the foramen. When stretching it, the upper lip and cheek must be drawn forcibly downwards. Subcutaneous section can be done in the same situation with a tenotome. To expose the nerve a curved incision, arranged so as to fall into the lines of the face, and about one inch in length, should be made with its mid-point over the foramen. After dividing the skin the levator labii superioris must be cut through, and the nerve then comes into view, and when the bleeding has been arrested, can be exposed clearly and stretched or a piece cut out. This operation, however, can be of little use when the teeth are the seat of the neuralgic pain, as the anterior dental nerve is not affected by the section. To divide this, it is recommended by Malgaigne to make the incision parallel to the margin of the orbit and immediately below it. A few fibres of the orbicularis palpebrarum are cut through, the origin of the levator labii superioris turned down and the nerve thus exposed at the foramen. The palpebral ligament is then separated from the margin of the orbit, and pushed upwards with the fat and the eyeball so as to expose the floor of the orbit. The nerve is next cut through as it lies in the canal in the floor of the orbit, with a strong tenotome, which is made to penetrate the antrum, and the terminal branch being seized in a pair of forceps at the infra-orbital foramen, it is forcibly dragged out of the canal by which the anterior dental branches are ruptured. The free part is then cut off. This operation is apt to be followed by suppuration in the antrum and orbit. Langenbeck and Hüter have recommended that instead of opening up the orbit, the nerve should be divided subcutaneously just before it enters the canal. To do this a puncture is made in the skin immediately below the outer commissure of the lids, and a blunt tenotome is pushed backwards and downwards till its point is felt to be in the spheno-maxillary fissure. The nerve is then pulled forcibly where it has been exposed at the infra-orbital foramen, while the tenotome is made to shave along the maxillary border of the fissure. As soon as the trunk is divided, it can be pulled out of the canal.

Bruns, Lücke, Lossen, and others, have exposed and divided the nerve in the spheno-maxillary fossa. In order to do this, an incision is commenced just behind the middle of the outer margin of the orbit, and carried downwards to a point opposite the last upper molar. From the upper end of this another is carried backwards to the root of the zygoma. The malar bone and zygoma are cut through, and the arch turned down with the masseter attached. The fat beneath is then pushed back, and if necessary some of the fibres of the temporal muscle which are inserted into the posterior part of the coronoid process of the jaw are divided. The posterior part of the superior maxilla is then recognized and followed upwards and backwards to the spheno-maxillary fossa. The nerve is then raised with a blunt hook and divided, as large a piece as possible being removed. As the internal maxillary artery and a plexus of veins which lie in the fat may cause troublesome hæmorrhage, the dissection should be carried out with a blunt instrument. After the operation the malar bone is replaced and secured by sutures. In some of the cases in which the operation has been performed considerable stiffness of the jaw has been left.

A simpler method of exposing the nerve is by following it directly backwards from the front through the roof of the antrum, as recommended by Carnochan. This may be done in the following way. A curved incision is made along the lower margin of the orbit from near the inner canthus to the malar bone. From the inner end or middle of this an incision must be carried downwards to the level of the ala of the nose, care being taken not to wound the mucous membrane of the mouth. The whole anterior wall of the antrum is then exposed by raising the flaps with the periosteum from the bone. The palpebral ligament is then divided and the fat of the orbit raised. A small piece of the margin of the orbit must then be cut away, so as to expose the nerve in its canal, the antrum being opened at the same time. The anterior wall of the antrum must then be freely removed, so as to give sufficient room. The posterior wall is then carefully broken through with a chisel and the fragments removed, so as to open up the spheno-maxillary fossa. The nerve may now be followed back and divided near the foramen rotundum. In doing this the termination of the internal maxillary artery may be wounded. If this happens the vessel may be twisted or tied, or if this fails the bleeding may be arrested by the cautery. Suppuration in the cavity of the antrum almost inevitably follows. In a case operated on by this method in University College Hospital, after avulsion of the nerve at the infra-orbital foramen had failed, a mucous polypus of considerable size was found in the antrum. The operation was followed by perfect relief of the neuralgia, but the cavity continued to discharge pus for several months, and as the normal aperture failed to allow sufficient drainage, the lower angle of the wound had to be kept open by a tube. Possibly this might have been avoided by making an opening from the lowest part of the antrum into the nose at the time of the operation through which the cavity might have been syringed out with an antiseptic fluid.

Third or Inferior Maxillary Division of the Fifth.—The three chief divisions of this nerve, the lingual, inferior dental, and auriculo-temporal, have all been submitted to operative treatment in neuralgia. The *lingual* is easily reached from within the mouth. It runs obliquely forwards to the side of the tongue from a point immediately internal to the last molar tooth. It is covered only by the mucous membrane, and forms a distinct ridge if the tongue be pulled forcibly outwards and to the opposite side. In this situation, the nerve can readily be seized and stretched by means of a blunt hook forced through the mucous membrane, the tongue being drawn to the opposite side while the nerve is being pulled upon. Section can be made by putting the nerve on the stretch, and passing a curved bistoury to the inner side of it opposite the last molar tooth, and then cutting towards the jaw. To remove a piece, a longitudinal incision should be made through the mucous membrane in the line of the nerve, which may then be drawn out with a blunt hook.

The *mental branch of the inferior dental* is easily reached, as it emerges from the dental canal. The foramen is situated directly below the interval between the bicuspid teeth. The nerve can be stretched subcutaneously by making a puncture in the skin opposite the first bicuspid at such a level as not to penetrate the mouth. A blunt hook is inserted through this, and forcibly scraped along the bone across the line of the nerve. The lip and chin must be pulled inwards while the nerve is stretched. The nerve may also be exposed, and a piece cut out if desired by a small incision in the same situation.

The *main trunk of the inferior dental nerve* has in some cases of intense and persistent neuralgia been divided by dissecting up a flap over the ramus of the lower jaw, applying a trephine to the bone so exposed, and cutting out a portion of it over that part where the nerve enters the dental canal, which is thus laid bare ; a portion of the nerve may then be excised, by being raised on a director, and snipped away with scissors.

The *auriculo-temporal nerve* can be reached only where it crosses the root of the zygoma after emerging from above the parotid gland. It lies immediately behind the temporal artery. In this situation it can be exposed by a small incision parallel to its course, and immediately in front of the tragus, care being taken to avoid the artery. Subcutaneous stretching had better not be attempted for fear of injuring the temporal artery.

The value of these operations is still somewhat doubtful. Many cases of permanent cure have been recorded, and temporary relief lasting for weeks or months very commonly results. No hesitation need therefore be felt in undertaking the less serious proceedings, such as subcutaneous stretching or exposure and division of the terminal branches. The more extensive operations, such as exposing the superior maxillary in the spheno-maxillary fossa, or the inferior dental in the canal, should be reserved for very extreme cases in which all milder proceedings have failed. Wood, of New York, has successfully divided the superior-maxillary nerve near the foramen rotundum. In one case of his which I have seen, a complete cure was effected ; the patient, a healthy man, being entirely free from the neuralgia one year and a half after the operation.

There is one form of neuralgia of the dental nerves that is so severe and so persistent in its general duration, and so paroxysmal in its attacks, that it constitutes a true *Tic*. This neuralgia may affect either jaw. I have most frequently met with it in the lower, and more commonly in women than in men. It occurs in people who have lost teeth ; and the pain, which is excessively acute and paroxysmal, commences in and darts from the contracted alveoli and the condensed and indurated gum covering them. It appears to be owing to the compression of the terminal branches of the dental nerves by the contraction upon them of the empty alveoli. Taking this view of the pathology of this form of neuralgia, I have treated it by the removal of a portion of the indurated alveolar border and gum. Some years ago I did this by removing a V-shaped piece of the bone by means of a Hey's saw; and more recently, I have in addition clipped away the bone by means of cutting pliers. Gross, who has directed attention to this form of neuralgia, uses the pliers only for the removal of the affected bone. In any case it is necessary to cut into, but not through, the body of the bone. By this incision, the dental canal may be opened in the body of the bone, and the nerve destroyed by means of the galvanic cautery.

MUSCULAR TIC.

Muscular tic of the face or "histrionic spasm" consists of almost constant twitching of the muscles of the face, sometimes so severe as to interfere with sleep, and always causing most serious annoyance and discomfort to the patient. During the last few years, the facial nerve has been stretched for relief of this affection in several cases. Godlee has collected 13, including 2 of his own. Keen has increased the number to 21. Of these 1, under the care of Southam, remained perfectly well five years after the operation; 4 were "improved" two years after, and 6 at periods varying from one year to three months; 1 experienced some relief, and in 6 the operation failed completely. In the remaining 3 the result was not certain. The operation causes at the time complete paralysis of the face, which may last from a few hours to three months according to the force used in stretching, and in every case except Southam's some return of the twitching has taken place when the nerve recovered its function. The operation is performed by making a slightly curved incision immediately behind the ear, reaching from the root of the mastoid process to nearly the level of the angle of the jaw. The anterior border of the process and the edge of the tendon of insertion of the sterno-mastoid are carefully cleaned, and the parotid turned forwards. The upper border of the digastric is next found, crossing the wound nearly transversely. The nerve is parallel to this, and according to Godlee it will be found emerging from under the middle of that part of the mastoid process which is exposed in the wound. After the digastric is exposed, the dissection must be carried out with a director and forceps as the deep parts of the wound approach the internal jugular vein. When the nerve is found and cleaned, it must be firmly stretched with two blunt hooks. Complete paralysis of the face should result if sufficient force is used.

In **clonic torticollis** the spinal accessory nerve has been divided in one case by Tillaux, and stretched by Nicoladoni, at its entrance into the sterno-mastoid. The division gave some relief, but the stretching only exaggerated the spasms.

TRAUMATIC PARALYSIS.

Traumatic paralysis is referable to three distinct sets of causes. First, it may arise from *Injury to, or Compression of the Brain* giving rise to localised paralysis when the cortical motor centres are injured, or to hemiplegia or more general paralysis when the deep centres are implicated, or pressure is exerted on the brain-substance generally. These conditions have already been fully described in the Chapter on the Injuries of the Head (pp. 751 and 759, Vol. I.). Secondly, it may arise from *Injury of the Spinal Cord* giving rise primarily or secondarily to lesion of the substance, either by laceration, compression, or ultimate disintegration. The effects produced will vary with the extent and seat of the injury, from complete paraplegia with loss of sensation in the paralysed parts, to irregular impairment of sensation and motion. (See Wounds of the Spinal Cord, p. 811, and Secondary Effects of Concussion of the Cord, p. 797, Vol. I.). Thirdly, *Injury to the Nerves* at any part of their course, from the roots to the terminal subdivisions of their trunks, may occasion paralysis of the parts supplied by them. The effect produced may be immediate, as from Section of a Nerve (see p. 491, Vol. I.) ; or more gradual, from Pressure (see p. 490, Vol. I.) ; or it may occur as the result of Chronic Neuritis following a strain, or other injury (see p. 495, Vol. I.).

These conditions having been already fully described, it only remains to notice here a form of paralysis that is occasionally confounded with the traumatic varieties ; viz., that arising from exposure to cold, or rheumatic paralysis.

Rheumatic Paralysis, or **Paralysis from Exposure to Cold** (Duchenne), is a form of disease more frequently spoken about than met with—that is to say, if we apply the term paralysis to loss of nervous power independently of inability to use the limb from muscular weakness, rigidity, or pain, or from similar conditions connected with the joints. Genuine rheumatic paralysis from affection of the nerves does, however, exist. Duchenne states that he has met with it in most of the nerves of the limbs, and it is far from uncommon in the facial nerve. It most frequently arises from exposure of the affected part to a draught or prolonged chill while the body is sweating. It is difficult to assign a distinct pathological cause for it ; that it is due to an actual inflammation of the nerve, a neuritis, may be assumed from the symptoms, and the paralysis is probably the result of compression of the fibres of the nerve from effusion into its sheath. The paralysis may arise in two ways. In the first variety there is prolonged evidence of neuritis before the loss of power appears. The first symptoms when a compound nerve is affected is pain along its course, gradually increasing in severity, stabbing or violently aching in character. With this there may be various modifications of sensation in the parts supplied by the nerve, as numbness, tingling, or hyperæsthesia. These symptoms are increased by movement. After lasting some time, even for weeks or months, the pains cease, and the muscles supplied by the nerve become paralysed, and after a time waste, and then electrical irritability becomes impaired.

In the second variety the preliminary symptoms of neuritis are wanting, the paralysis appearing immediately after exposure to cold. This is commonly observed in the facial nerve, or in the musculo-spiral and occasionally in other nerves. Duchenne states that he has collected over 100 cases of sudden paralysis of the latter nerve occurring after exposure to cold, usually from sleeping with the arms exposed to a draught. The symptoms of paralysis of the musculo-spiral have already been described (Vol. I., p. 596). Duchenne states that in paralysis from exposure to cold the whole of the parts supplied by the nerve in the forearm are paralysed, whereas in wrist-drop from lead-palsy the supinator longus escapes. In paralysis occurring in this sudden way from cold the electrical irritability of the muscle remains normal, the muscles supplied by the facial nerve alone forming an exception to this rule. This is explained by supposing that this nerve is exposed to more severe pressure when it swells in consequence of its course being through a long canal.

It is important to distinguish these forms of paralysis from that arising from other causes—more particularly from the traumatic forms. This may usually be done by attending to the preliminary history of neuritis in the first form, in which there is also frequently a co-existent or antecedent rheumatic affection of the joints or muscles, and in the second form by the maintenance of the normal irritability of the muscles, remembering, however, that facial paralysis from cold forms an exception to the rule.

The *Treatment* in the early stages is that of neuritis, free counter-irritation and rest, with the administration of salicylate of soda if there are any general signs of rheumatism. When paralysis is clearly developed, faradization must be employed to prevent wasting of the muscles. By these means a cure is always effected, although the recovery is often very slow.

NEUROMA.

By **Neuroma** is meant a tumour connected with a nerve. The common neuroma is a fibroma springing from the perineurium. (See also, p. 1022, Vol. I.) It is composed of dense white fibrous tissue, and as a rule the fibres of the nerve are stretched over it or pass along one side, seldom being involved in the mass.

This tumour may vary from the size of a millet-seed to that of an orange; it is usually solid, but when it attains a large bulk, a cavity may form in it, containing a yellowish or brownish serous-looking fluid, apparently owing to the disintegration of the central portions of the mass. In shape it is usually oval or oblong, the long axis corresponding to the course of the nerve (Fig. 424); it grows slowly, and is movable transversely, but not in the direction of the nervous trunk on which it is seated when that is put upon the stretch by position; it has no appearance of malignancy, and, however large it becomes, it never contracts adhesions to the integument nor involves its structure. Neuroma commonly affects only the nerves of the cerebro-spinal system; but Bérard has met with one case of the disease on a ganglionic nerve. The nerves of special sense are very rarely the seat of this disease. Indeed, the only recorded case with which I am acquainted of a neuroma connected with one of those nerves, is one described by Lidell of New York, of a neuroma of the optic nerve filling up the orbit, flattening and protruding the eye; it was extirpated together with the contents of the orbit.

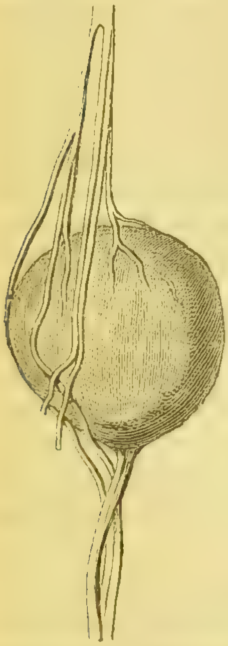

Fig. 424. — Neuroma with Nervous Filaments spread out over Tumour.

Most commonly the tumour is single, and is usually painless. As it increases in size it may become the seat of severe lancinating or neuralgic pain, which extends, however, only to the parts below the tumour, and is commonly paroxysmal. The motor function of the nerve is very seldom affected. The pain is evidently due to the stretching of the nervous twigs as they pass over the tumour. Single neuromata are sometimes not only painful but acutely tender when touched; but when many tumours are present it is a singular fact that they are always painless and unattended with any inconvenience except such as arises from their numbers and bulk. The number of such tumours is sometimes amazingly great : thus, in one of R. W. Smith's cases, described in a monograph which contains a most full and accurate account of this disease, he counted in the two lower extremities alone more than 250 of these growths, besides those in other parts of the body. In another case related by him, there were upwards of 200 small neuromata scattered over the sides of the chest and abdomen, 450 on the right lower extremity, and upwards of 300 on the left ; altogether probably not less than 2000 of these growths in "this unprecedented case." Multiple neuromata are often congenital, and occur in young subjects.

Other tumours besides fibromata are occasionally met with in connection with nerves. Myxomata are perhaps the most frequent. In 1870 I amputated the leg for a spindle-celled sarcoma of considerable size, which was found on dissection to have sprung from the posterior tibial nerve.

Under the name of **plexiform neuroma**, Verneuil has described a very rare form of tumour met with in the subcutaneous tissue, especially in the neck and upper part of the face. It is composed of a group of nervous twigs, thickened by a fibrous growth in the epineurium. The twigs are convoluted, twisted in all directions, and nodular, and are held together by loose areolar tissue. It is probably always of congenital origin.

The **painful subcutaneous tubercle** (see p. 1016, Vol. I.) is probably also a fibroma connected with a nervous twig.

Traumatic Neuromata may arise from the wound or partial division of a nerve. The central end of every divided nerve becomes more or less bulbous, the enlargement being composed partly of dense fibrous tissue and partly of newly formed nerve-fibres. As a rule this condition, which must be regarded as normal, is unattended by any pain or discomfort. Occasionally, however, the enlargement reaches the size of a nut or pigeon's egg, and then the growth must be regarded as a true tumour. It may be acutely tender and give rise to the most intense neuralgic pain.

Treatment.—No neuroma should be interfered with unless it is causing inconvenience by the pain it gives rise to or by its bulk. If it becomes necessary to do something to relieve the patient, excision of the tumour is the only possible mode of treatment. In idiopathic neuromata the attempt must always be made, by cautious dissection, to remove the tumour from the nerve, without cutting this across. This can be done in most cases without difficulty. If it is impossible to save the whole trunk, a few fasciculi may possibly be preserved which will maintain the continuity of the nerve and facilitate subsequent restoration. If complete division is unavoidable, an effort must be made to suture the divided ends after relaxing the parts as much as possible by position. Even if this fail, restoration of function may sometimes take place.

Traumatic neuromata of stumps are treated by excision.

TETANUS.

Tetanus is a disease consisting essentially in an excited state of the spinal cord and the medulla oblongata, in fact of the whole true spinal system, giving rise to painful and continued spasms of the voluntary muscles, alternating with incomplete relaxation, and usually terminating fatally.

Causes of Tetanus.—Tetanus is in the great majority of instances of **Traumatic** origin. It is stated, however, that it may arise from other sources besides wounds, occasioning the **Idiopathic** form of the disease : thus, for instance, it has been said to have been due to the presence of worms in the intestinal canal, or to exposure to cold and wet, and it has been known to follow the ligature of the umbilical cord in infants, and even the uterine irritation following abortion. These causes, however, rarely give rise to it in this country, and there is some reason to believe that many of the so-called idiopathic cases are not identical in nature with true tetanus.

Tetanus may occur at all *ages*, from the earliest infancy to an advanced period of life. In hot climates it is common amongst newly-born infants, in the form of *Trismus Neonatorum.* In this country it rarely occurs at this very early period of life, but is most common in young adults. I have most frequently observed it between the ages of 16 and 25, and after that in old people ; but it may occur at any period of life. It is far more common amongst *males* than females—in the proportion of about four to one. *Season of the year* seems to exercise little influence over it. It occurs in all states of the atmosphere, and at all periods of the year ; but is certainly most common when the weather is suddenly changeable—alternating from heat to cold. Indeed, long exposure to cold and wet, more particularly after the body has been heated, is said to be the most common cause of tetanus when it occurs independently of surgical injury, and is a frequent predisposing cause in persons who have been wounded.

Tetanus may be occasioned by injuries that do not give rise to breach of surface ; thus I have known it occur in a child who was suddenly thrown down upon its back by another at play, in a girl from a boy jumping on to her back, and in a lad by another striking him on the back by running a wheelbarrow at him ; and Reid mentions a case produced by the stroke of a whip ; but in the great majority of cases, it is directly occasioned by a *wound* of some kind.

The *kind of wound*, as well as its situation, doubtless influences materially the occurrence of the disease. Though it certainly more frequently follows punctured, contused, and lacerated, than clean-cut wounds, yet it occasionally complicates these, even when they are made in surgical operations ; thus, it has been known to follow the removal of the breast, amputation, the ligature of the larger arteries, and the operation for hernia. The minor surgical operations also are not free from the possibility of this dangerous complication. It has been observed after the operation for fistula in ano, the ligature of piles and varicocele, and the removal of nasal polypi. I have seen a fatal case resulting even from the establishment of an issue ; and burns are occasionally followed by it. It is the common belief, both in the profession and out of it, that wounds of the hands and feet, and more especially of the ball of the thumb and of the great toe, are more likely to be followed by tetanus than those in other situations. I think the truth of this opinion may be doubted ; though it is not improbable that tetanus may occur more frequently after injuries of these regions than of other parts of the body, simply because punctured and lacerated wounds are more common here than elsewhere. The statistics of the American Civil War are very complete on this point. Of 505 cases, 21 followed wounds of the head or neck, 55 of the trunk, 137 of the upper extremity, and 292 of the lower. Of the 137 wounds of the upper limb which were followed by tetanus, 96 were above the wrist; and of the 292 of the lower extremity, only 57 were of the foot.

Tetanus may occur in all *constitutions*—in the strong and robust, and in the feeble and emaciated. It is especially apt, however, to occur in feeble and debilitated individuals, and, indeed, may be looked upon as a disease of debility; hence any condition that lowers the tone of the nervous system is especially likely to occasion it. When it occurs in persons who are otherwise strong and in the prime of life, it will usually be found that they have been exposed to causes of depression affecting the nervous system. Thus, in tropical climates, as in some of the West India Islands, and amongst the marshes of Cayenne, it occurs with peculiar frequency, and after the most trifling scratches or punctures. Poland states that the mortality from it is in London ·025, whereas in Bombay it causes 2·5 per cent. of the total deaths. It is interesting to observe, that the natives of hot climates are far more liable to this disease than Europeans resident there. In the American Civil War, 3·1 per cent. of the cases occurred amongst the negro troops, who furnished only 2·7 per cent. of the total number of wounds.

In *military practice* tetanus is of common occurrence. Its frequency varies much in different campaigns and under different circumstances, especially of season and climate. In the Peninsular War, it was estimated to occur in the proportion of about one case in every 200 wounded; in the Schleswig-Holstein War of 1849, according to Stromeyer, once in about 350 cases. In the Crimea it appears to have been of rare occurrence. Alcock's estimate of one to every 79 wounded is evidently too high. In the American War it occurred in 0·2 per cent. of the wounded. After naval engagements, however, the mortality has often been high, more particularly in tropical climates. Sir G. Blane states that, after Rodney's action in the West Indies, out of 810 wounded 20 were attacked with tetanus, being one in 40. All European Army-Surgeons are agreed, that sudden changes from heat to cold are amongst the most frequent causes of tetanus amongst the wounded. Thus Larrey states that, after the battle of Moskowa, although the number of wounded was immense, there were few cases of tetanus, the heat being very great and continuous; whilst after Bautzen, where the wounded were left on the field all night exposed to severe cold, more than 100 had tetanus; and after the battle of Dresden, when great heat was followed by much wet and cold, the wounded suffered most severely. So, after some of the Indian battles, as Chilianwallah and Ferozepore, where the wounded lay exposed to cold nights after very hot days (Macleod), tetanus was of very frequent occurrence. In the American Civil War tetanus does not seem to have arisen from exposure of the wounded to cold and night-air. Chisholm states that although, from the wooded nature of the country in which the battles were often fought, wounded men were not unfrequently left for two or three days on the ground, tetanus did not appear to be more frequent amongst them than in those immediately cared for. Hennen states that a draught of air, whether hot or cold, directly blowing on the patient, is the most fertile cause of tetanus.

The frequency with which tetanus occurs varies much. It often happens that not one case occurs in a hospital for some years, and then several are met with in close succession or simultaneously. The frequency of the disease seems to have diminished since the introduction of the antiseptic treatment of wounds.

Period of Occurrence.—Tetanus may take place at any period after the infliction of the wound that occasions it. In hot climates especially, it may occur very speedily; thus, Robinson relates the case of a negro servant in the West Indies, who scratched his finger with a broken plate, and died of tetanus in a quarter of an hour. It is very seldom, however, in temperate climates, that it supervenes before the fourth or fifth day, usually from that to the tenth day. Larrey, who had great experience of this disease during Napoleon's campaigns in Egypt, met with it most frequently between the fifth and fifteenth days after the infliction of the wound. According to the experience of the Surgeons of the Peninsular War, under whose observation many hundred cases came, the disease does not show itself after the twenty-second day; but, though this may be the general rule, Sir G. Blane has related a case in which it took place as late as a month after the infliction of the wound. It has been stated that it may occur after the cicatrization of a wound is completed; but this is doubtful.

In the American War, out of 367 cases in which the day of appearance of the disease is noted, it followed secondary amputations in twenty-one cases during the first day after the operation; and in six it appeared in the first twenty-four hours after the original wound. After this but few cases appeared till the fifth day, when 19 are recorded. The highest number was 37, on the eighth day, and by the fifteenth day the number fell to 6. Seven cases occurred between the 26th and 30th days, and 23 after the end of a month.

Forms.—Tetanus may be *Acute* or *Chronic;* being in some instances fatal in the course of a few hours, but usually lasting for three or four days. Poland states that at Guy's Hospital 51 per cent. of the cases were fatal before the fifth day after invasion. In the American War, out of 358 cases, 1 recovered and 69 died during the first day; 1 recovered and 83 died on the second day: 49 died on the third; 31 on the fourth; 22 on the fifth; 19 on the sixth; 14 on the seventh; and 7 on the eighth day. Thus of the acute cases two, evidently slight in character, recovered, 294 died before the end of the eighth day, and in 203, or more than half, the disease did not exceed three days in duration. From the ninth to the nineteenth day inclusive, 36 died and 6 recovered; from the twentieth to the twenty-seventh inclusive, 7 died and 7 recovered, and 6 survived beyond the twenty-seventh day and finally recovered. The longest period during which the disease lasted was forty-nine days. These interesting statistics confirm the view that the more chronic the disease becomes the better is the chance of recovery; indeed, if the patient survive the tenth day, the prospect of a favourable issue to the case is materially increased. As a general rule, the danger is in the ratio of the acuteness of the attack, both as to severity and also as to rapidity of invasion after injury.

Symptoms.—The invasion of the disease is sometimes preceded by a general uneasiness on the part of the patient, a feeling of illness or weakness, or a sense of impending mischief. Abernethy was of opinion that tetanus was usually ushered in by a disturbed state of the digestive organs, the stools being offensive and indicative of much gastric irritation. When the disease sets in gradually, it may be somewhat difficult of recognition in its early stages; if it come on suddenly, its nature is immediately evident. It is a remarkable fact that the cramps do not begin in the part injured; but wherever this may be situated, they are always first noticed in the muscles of mastication, of the face, and upper part of the neck; and, throughout, these and the muscles of respiration are principally affected. The nervous disturbance is at first confined to the muscles supplied by the motor branch of the fifth, by the portio dura of the seventh, and by the spinal accessory. These nerves appear to be alone affected; the sensory division of the fifth is never influenced throughout the disease. The spasm may be confined to the muscles supplied by these nerves, as is the case in trismus; but it soon spreads to those supplied by the spinal nerves. The first symptoms usually consist in the patient feeling a stiffness or soreness about the jaws and throat, being unable to open his mouth widely, to take food or drink, the muscles about the temples, jaw, and neck feeling stiff and rigid; this condition has given to the disease the popular term of *lock-jaw*. As the affection advances, the countenance assumes a peculiar expression of pain and anguish, the features are fixed or convulsed from time to time, and the angles of the mouth drawn up, constituting the appearance called the *risus sardonicus*. When fairly set in, the disease is marked by spasms of the voluntary muscles of the most violent character, with much pain and only partial remissions. The pain is of that kind that attends ordinary cramp in the muscles, as of the legs, and is usually very severe. The spasms are often jerking, the patient being suddenly thrown up or twisted on one side; the breath is drawn with a loud sobbing catch from spasm of the diaphragm, and from the same cause there is usually violent pain experienced in the epigastric region, darting across to the spine. The muscles of the trunk are usually affected next in order of frequency to those of the head and neck, the body being bent backwards so as to form a complete arch (*Opisthotonos*); more rarely it is drawn forwards (*Emprosthotonos*); and still less frequently to one side (*Pleurosthotonos*). In some cases the body becomes perfectly rigid, like a piece of wood, the belly being drawn in, and the chest expanded. It is said that in severe cases the spasms have been so violent that muscles have been ruptured, teeth broken, and the tongue lacerated. In the numerous cases of tetanus that I have unfortunately witnessed, it has rarely fallen to my lot to see any effects of this kind produced; the spasms, indeed, being in general not very violent, though continuous and very painful. The only muscles that I have seen torn have been the recti of the abdomen.

The intellectual faculties are not disturbed, and the mind continues clear to the last. Cases of tetanus occasionally prove fatal without any elevation of temperature; but in most instances there are great heat of surface, profuse sweats, and quickness of pulse; not so much from any febrile disturbance, as apparently from the violence of the muscular contractions. In most cases this symptom is peculiarly marked, especially towards the end of the case, when the temperature may rapidly rise to extraordinary heights. Thus, Wunderlich has recorded a case in which it reached 112°·55 Fahr. immediately before death. It may rise a few tenths of a degree higher after death in these cases. The prolongation of life appears to depend greatly upon the intensity of the convulsive movements: the more severe these are, the sooner does death result. The fatal termination most commonly occurs from exhaustion consequent on the frequency of the tetanic spasms; much more rarely from asphyxia during a convulsion.

Pathology.—It might reasonably be expected that a disease so marked in its symptoms would leave behind it characteristic pathological changes clearly indicating its nature. This however is not the case. Beyond the local injury from which the tetanus arose, the *post-mortem* appearances to the naked eye are most commonly those of a perfectly healthy body. Should the patient have died of asphyxia during a spasm, the distension of the right side of the heart, the engorgement of the lungs and the general venous congestion characteristic of that condition are present. Beyond this changes have been observed in the nerves at the seat of injury, and the microscope has revealed alterations of structure in the spinal cord.

State of the Nerves at the Seat of Injury.—In all cases of fatal tetanus that I have seen in which a careful dissection has been made, the signs of inflammation of a nerve communicating with the wound have been found; and the vascularity, which is often very intense, may be traced up the sheath, often to a considerable distance. In a case of tetanus following a wound of the knee, in a patient who died in University College Hospital, a small branch of the internal cutaneous nerve was found to have been injured, and was inflamed. In another patient who died of tetanus about sixteen days after treading on a rusty nail, a black speck was found on the internal plantar nerve, where it had been wounded by the nail. In a man who died of acute tetanus a week after receiving a lacerated wound of the dorsum of the foot, the digital nerves were found to be sloughy, and evidences of inflammatory irritation extended some distance up the musculo-cutaneous nerve. In another case under my care, in which tetanus resulted from a bruise of the back, and terminated in death, the injured nerve (a dorsal branch) was found lying bare and reddened in the wound; and, on tracing it up to the spinal cord, its sheath was found to be much injured and ecchymosed. In another instance, in which tetanus followed a wound of the wrist, the external cutaneous nerve was found in a similar inflamed state.

On the other hand, experience has shown that operations on nerves such as section, avulsion or suture are not more commonly followed by tetanus than other surgical procedures, and that neuritis from injury and other causes very frequently occurs without further serious consequences. Granting, therefore, that it is possible that the peripheral irritation due to the inflamed state of the nerve may take part in the causation of the convulsions, it is evidently not enough to account for the whole phenomena of the disease.

The Pathological Conditions found in the Spinal Cord in cases of tetanus have been studied by Lockhart Clarke, Dickinson, and Allbutt. Lockhart Clarke, in at least six cases, observed lesions of structure in the spinal cord, consisting of disintegration and softening of a portion of the grey substance of the cord, which appeared in certain parts to be in a state of solution. The fluid thus formed was in some parts granular, holding in suspension the fragments and particles of the disintegrated tissue, but in many places it was perfectly pellucid. He considers this due to hyperæmia of the cord, accompanied by exudation and disintegration. Dickinson has described intense hyperæmia with a structureless exudation poured out around the vessels in many parts of the grey matter, breaking down the surrounding tissue. He observed also some hæmorrhages in the white columns. These observations have been confirmed by Clifford Allbutt, but the exact significance of the changes observed is still uncertain.

The absence of any constant and distinct pathological lesion led some

Surgeons to the hypothesis that **tetanus is due to the action of a specific virus** which, like strychnine, stimulates the motor centres and thus gives rise to muscular spasm. It was suggested that this poison might be developed as a consequence of peculiar chemical changes in the secretions of an unhealthy wound, or possibly, when no wound, was present, in the sweat or some other secretion. Billroth, who inclined to this theory, attempted to obtain proof of it by injecting the blood of a patient who died of tetanus into dogs, but without success. Later experimental observations have, however, furnished more definite results, and have tended to show that tetanus may be due to the action of a chemical poison developed in connection with the growth of a special form of bacillus. The first evidence of the infective nature of tetanus was obtained by Carle and Rattone from a patient who died of that disease originating from a suppurating acne pustule. They removed the inflamed area immediately after death, and having squeezed the fluid from it and diluted it with sterilized water injected the emulsion so prepared beneath the skin in twelve rabbits. Eleven of these died of undoubted tetanus. The blood of the dead animals failed to induce the disease when injected into others, but pieces of the sciatic nerve, into the sheath of which the emulsion had been introduced in four instances, were found, when crushed up in water and injected, to give rise to tetanus. In the same year Nicolaier, while making observations on the bacilli of earth, incidentally found that in a considerable number of cases the subcutaneous injection of earth in rabbits, mice and guinea-pigs was followed by a fatal disease exactly resembling tetanus. Whenever this occurred there was present in the tissues, with other organisms, a fine and very small bacillus. Further observations showed that pus from the seat of inoculation produced the same disease in other animals, and contained the organism. It was subsequently cultivated on coagulated serum and inoculated with positive results. Dogs were not affected by the virus. In 1886 Rosenbach communicated a disease exactly resembling tetanus to rabbits by inoculating them with matter taken from the edge of the sore in a case of frost-bite, which terminated fatally from acute tetanus. In the diseased tissues he found, amongst other organisms, a very fine bacillus exactly resembling that described by Nicolaier. He obtained cultivations of this almost pure, being contaminated only by a septic bacillus which could not be separated, and with this cultivation he uniformly obtained positive results on inoculating rabbits. In all these cases the peculiar fact was observed that the spasm commenced first in the limb into which the virus was injected, and subsequently extended to the whole body. More recently, E. O. Shakespeare, of the Philadelphia Hospital, has succeeded in communicating tetanus to rabbits by injecting an emulsion prepared from the medulla and spinal marrow of horses and mules dead of that disease. The evidence at present before us seems, therefore, strongly to support the view that tetanus, like hydrophobia, belongs to the class of infective diseases, but much more extended investigations are required before we can hope to know certainly the source and nature of the virus and its exact mode of action.

TREATMENT.—The treatment of tetanus is local and constitutional. The **Local Treatment** has for its object to bring the wound into as healthy a state as possible, and to remove every source of irritation from it. Even if the infective theory of tetanus be true, local treatment is still of the greatest importance, as the chemical poison which gives rise to the disease may, for all we know, be generated in the wound only, and by cleaning this we may cut off the supply at its source. It seems also probable, without accepting either the theory that the spasm is purely reflex, or that it is due to an ascending neuritis extending to the cord, that local irritation may aggravate the spasms and give rise to the more violent convulsions which so rapidly exhaust the patient. Thus, in a case lately in University College Hospital, the patient constantly complained of pain in the wound immediately before the commencement of a general spasm. In order effectually to remove all local disturbance, recourse has been had to amputation ; but though this may have succeeded in checking some of the more chronic forms of the disease, yet milder local means have sufficed equally well, and in the majority of cases it has had no effect ; hence so severe an operation can scarcely be recommended for general adoption. The division of the trunk of the injured nerve, at some distance above the wound, if there be one that has been punctured or lacerated, has occasionally proved successful. Thus, in a case of tetanus following injury of the supra-orbital nerve, Larrey cut this across, and the patient recovered. In a midshipman, in whom tetanus came on the day after the sole of the foot had been wounded by treading on a rusty nail, Murray divided the posterior tibial nerve, and the patient got well. In those cases in which no special nerve appears to have been injured, Liston's recommendation of making a Λ-shaped incision down to the bone, and above the part, so as to insulate it completely, may be advantageously followed. After the nerve has been divided, or the part properly insulated, some solution of atropine may be carefully applied to it, so as still further to lessen local irritation. Instead of dividing the nerve leading from the source of irritation, it has been suggested that the operation of stretching should be performed. This has been done in a considerable number of cases, and as with every other of the scores of remedies, local and constitutional, that have been recommended for tetanus, recoveries have taken place after its employment. On the other hand, in acute cases it has proved as impotent as the rest.

In the **Constitutional Treatment** of the disease it is necessary to bear in mind that tetanus is an affection of debility, the violence of the spasmodic paroxysms giving an appearance of false strength to the patient ; and that the principal source of danger and death is the exhaustion induced by the energy of the muscular movements. The means adopted should, therefore, have for their object the removal of irritation and the support of the patient's strength, so as to enable him to hold up against the disease.

Nothing can be more unsatisfactory than the treatment of the *Acute* form of traumatic tetanus. In it, all medicines are useless as curative agents. But, though medicines are of no avail as means of cure, they may act as palliatives, and afford relief to the patient ; and much may be done by the Surgeon to mitigate his sufferings, and to place him in a favourable condition to withstand the exhaustion, and to lessen the torture of the spasms. With this view, the first thing to be done is to clear the bowels out well with an aperient dose ; aided, if necessary, by a turpentine enema. The patient should then be kept perfectly quiet in a room by himself, a screen or muslin curtains, as recommended by Marshall Hall, being drawn round the bed, as noise or movement of any kind greatly increases the spasms. In order to allay the spinal irritation the most effectual means consists, perhaps, in the plan recommended by Todd, of applying ice along the whole length of the spine : this is best done by a caoutchouc spine-bag. This is a powerful depressing agent, and, unless care be taken, may lower the heart's action too much, or indeed completely stop it. It may, however, be applied with safety for six or eight hours, the condition of the patient being carefully watched in the meanwhile. Sedative or antispasmodic agents are of no use whatever in acute traumatic tetanus. I have seen many drugs of this kind employed, without producing any effect in lessening the violence of the convulsions. In most cases, however, the inhalation of chloroform, or the administration of chloral, materially diminishes their severity, and gives the patient at least temporary ease.

In the *Subacute* or *Chronic* form of the disease, recovery is much more likely to take place ; and it is only in these cases that antispasmodics and sedatives have been of use, and in these also chloroform and chloral are far more beneficial than in the acute cases. Almost every drug in the pharmacopœia of a tonic, sedative, or antispasmodic nature has been employed in tetanus ; and the recovery which has occasionally resulted has been perhaps over hastily attributed to the remedy, rather than to the employment of those dietetic and hygienic means which are of the first importance, by enabling the patient to live on until the disease wears itself out. Tonics, especially iron and quinine, have been employed by some. Elliotson was strongly impressed with the value of the carbonate of iron. Sedatives in all forms—conium, belladonna, opium, and their alkaloids—have been largely and most ineffectually employed. Miller speaks highly of cannabis indica pushed to narcotism, three grains of the extract, or thirty minims of the tincture, being given every half hour or hour ; and Haughton has employed nicotine in one-drop doses administered every second hour, with some apparent success in severe cases of traumatic tetanus.

The Calabar bean (*Physostigma*) is the remedy that perhaps deserves physiologically the most attention ; for as it is nearly if not quite antagonistic to the tetanic spasms of strychnia, it was hoped that it would be found equally useful as a sedative to the spinal cord in those arising from traumatic causes. In E. Watson's hands, very successful results followed its administration. Yet it is far from being a specific. I have tried it in several cases, with no appreciable good effect. It may be given by the mouth, hypodermically, or *per anum* : in the form of a solution or a tincture of the extract in half-grain doses, by the mouth ; hypodermically, in doses of one-sixth of a grain ; *per anum*, in grain doses. The dose should be given at least every second hour, until complete contraction of the pupil occurs. Stimulants, as brandy, should be administered to counteract the depression that will result from the use of the drug. At the same time that recourse is had to such measures as these, it must not be forgotten that the disease is one of great exhaustion, and that the patient will die worn out, unless he be supplied with plenty of nourishment. Beef-tea and wine should, therefore, be administered by the mouth, as long as the patient can swallow, and nutritious enemata by the rectum ; and in this way the powers of life may be supported until the violence of the disease expends itself. I am, however, disposed to think that even in these chronic cases, much more may be done by simple than by specific treatment. Clearing out the bowels by a turpentine enema, breaking the violence of the spasms and giving the patient rest and ease by chloroform inhalations or by chloral enemata, and keeping up the powers of the system by injections of beef-tea, egg, and brandy into the rectum, till the disease wears itself out, appear most likely to be followed by a satisfactory result, when used in addition to the hygienic measures recommended in the acute form of the disease. It is certainly more rational to employ such measures as these, than in the vain hope of finding a specific for tetanus, to be constantly recurring to antispasmodics and sedatives, which repeated experience has proved to be useless as curative agents.

CHAPTER XXXIX.

DISEASES OF THE LYMPHATIC SYSTEM.

INFLAMMATION OF THE LYMPHATIC VESSELS.

LYMPHANGITIS, or as it was formerly called, **Angeioleucitis,** is a diffuse inflammation of the lymphatic vessels.

Causes.—In the vast majority of cases it arises from the irritation caused by the presence within the vessels of the products of an infective inflammation affecting the tissues from which they derive their lymph. It thus forms rather a complication of these inflammations than an independent disease. Very commonly it is associated with cutaneous erysipelas, but it is also met with in other forms of infective inflammation; thus it is a frequent result of the inoculation of virulent matter from dead bodies, and is occasionally seen in the lymphatics leading from a soft chancre. In most cases, therefore, a wound or abrasion serves as the starting point of the inflammation. It is very rarely indeed that lymphangitis occurs without some such external cause; yet I have seen cases in which careful examination has failed in detecting any breach of surface or evidence of local infection. The disease is predisposed to by the same causes that favour the development of erysipelas, as by atmospheric vicissitudes, by particular seasons of the year, more especially the early spring, and by epidemic influences. Broken health and the neglect of hygienic precautions also tend to induce it.

Morbid Anatomy.—The walls of the inflamed vessel become swollen, softened, and infiltrated with small round cells, and the endothelium desquamates. Tessier states that the lymph coagulates, forming a rosy clot which plugs the vessel. The inflammation, though commencing from irritation within the vessel, soon extends beyond its walls, the surrounding areolar tissue becomes swollen and infiltrated with inflammatory products, and sometimes suppuration may take place around the inflamed lymphatic.

Symptoms.—During the progress of an ordinary injury, the patient is seized with chills or rigors, with considerable elevation of temperature reaching 103° F. or 102° F., attended, perhaps, by vomiting or diarrhœa. These symptoms may precede by twelve or fourteen hours the local signs of the disease, but more commonly accompany them. On examining the part it will, if superficial, be seen to be covered by a number of fine red streaks, at first scattered, but gradually approximating to one another so as to form a distinct band, about an inch in breadth, running from the part affected along the inside of the limb to the neighbouring lymphatic glands, which will be felt to be enlarged and tender. The band itself feels somewhat doughy and thickened. Sometimes one lymphatic can be felt hard and isolated like a piece of whipcord. There is usually more or less œdema of the limb, from the implication of the deeper lymphatic vessels and their obstruction by the inflammation. Along the course of the inflamed lymphatics, erysipelatous-looking patches not unfrequently appear, and coalesce until they assume a considerable size, and constitute as it were a distinct variety of erysipelas. In some cases the glands are affected before any other local signs manifest themselves, owing probably to the deeper-seated lymphatics having been first implicated ; or possibly to the direct absorption of and deposit in them of some infective matter that constitutes the primary source of the inflammation. Not uncommonly throughout the disease the inflammation continues to be confined principally to this set of vessels, giving rise to great and brawny swelling of the limb, but without much if any superficial redness. The constitutional disturbance. which is at first of the active inflammatory type, may gradually subside into the asthenic form.

Results.—The disease usually terminates in resolution at the end of eight or ten days ; not uncommonly it runs on to erysipelas ; and in other cases, again, localized suppuration may take place, sometimes in the form of one large deep-seated abscess in the iliac fossa or in the thigh if the lower extremity, or under the pectorals and in the axilla if the upper extremity be the seat of irritation ; or a chain of abscesses may form along the course of the inflamed lymphatics and in the glands to which they lead. In some instances, after the disappearance of the disease, a state of chronic and rather solid œdema of the part may be left, giving rise indeed to a species of false hypertrophy, and constituting a troublesome consequence. More rarely death results, either from general blood-poisoning, or as the effect of exhaustion from prolonged suppuration of deep-seated abscesses.

The **Diagnosis** of inflammation of the lymphatics has to be made in its early stages from phlebitis and erysipelas, and of the abscesses in later stages from those of pyæmia. From phlebitis it is easily distinguished by the superficial redness of lymphangitis, and the absence of the cord-like plugged vein. From erysipelas it is distinguished by the want of a defined margin to the redness, and by its extending in the line of the lymphatic vessels only ; but the affection in most cases is closely allied to erysipelas, and in others merges into it, and consequently the distinction is often of little consequence. The acute lymphatic abscess is usually distinguished without difficulty from the pyæmic ; the lymphatic abscess being, if deep, solitary ; if superficial and multiple, confined to the track of the previously inflamed absorbents ; in either case being always between the starting point of the primary source of irritation, or wound, and the glands ; in the calf, thigh, or iliac fossa, if the primary irritation be in the lower extremity, in the axilla if in the upper. The fever is moreover more continued, and the severe rigors and sweatings of pyæmia are wanting.

Treatment.—In superficial lymphatic inflammation of the skin and integumental structures, the application of belladonna, as recommended by C. Heath, is the most efficient agent in subduing the local process ; a paste of equal parts of the extract and of glycerine should be thickly smeared over all the inflamed parts, and covered with a thick layer of cotton-wool ; the limb at the same time being kept elevated. As an alternative treatment, though of inferior value, hot poppy-fomentations may be used. If after the acute inflammation has been subdued much chronic induration and œdema occur, bandaging, so as to compress the limb, and methodical friction will be of service. If abscesses form, they should be opened early and treated on ordinary principles. The *constitutional treatment* is the same as for erysipelas.

No depletion is ever justifiable, and stimulants are often required in considerable quantities, with abundant liquid food of a nourishing kind. Perchloride of iron and quinine are often useful.

VARIX OF THE LYMPHATIC VESSELS.

Varix of the Lymphatics has been occasionally met with, both in the superficial and deep networks and in the lymphatic trunks. The part most commonly found affected has been the inner side of the thigh ; but the disease has been seen also in the anterior wall of the abdomen, about the ankle and elbow joints, and on the prepuce. In the superficial lymphatics, the varix first appears in the form of small elevations, giving the skin an appearance which has been compared to the rind of an orange ; it subsequently takes the form of little vesicles covered with a thin layer of epidermis. Varix of the larger lymphatic trunks frequently accompanies the condition just described. The vessels may either be dilated cylindrically into round beaded enlargements, often semi-transparent, and but slightly compressible ; or ampullæ may be formed on them, giving rise to more or less soft swellings, fluctuating under the finger. There is some œdema, attributable either to obstruction of the lymphatics or to the impeded flow of the lymph.

In 31 out of 55 recorded cases, a discharge of lymph (**Lymphorrhœa**) has been observed. This has been seen to occur also without varix, as the result of wound. In the latter case, the flow is continuous ; while in the lymphorrhœa which attends varix it is to some extent intermittent. The identity of the fluid discharged with lymph has been established by chemical and microscopic examination. An excessive discharge of the fluid is apt to produce symptoms of general debility, of the same kind as those induced by hæmorrhage.

Treatment.—Spontaneous cure of lymphatic varix has been observed in cases where the penis was affected, the disease being the result of the obstruction to the flow of lymph caused by buboes. In other instances, various plans of treatment have been tried, with apparently indifferent result. Caustics have been used by several Surgeons, but, as the disease is often deeply seated as well as superficial, with but little effect. Beau treated three cases successfully by introducing a seton into the dilated lymphatic vessels, and exciting adhesive inflammation. B. Bell advised ligature of the lymphatic vessel, from which the discharge of fluid takes place. Compression by means of a bandage has been recommended by Nélaton.

ELEPHANTIASIS OF THE LEGS AND SCROTUM.

Elephantiasis Arabum, or, as it is often called, the **Barbadoes Leg**, is an affection that is common in many tropical countries, in the West Indian Islands and in South America more particularly. It is met with, though comparatively rarely, in Europe. The disease usually affects one of the lower extremities (seldom both), the scrotum, or the labia, which may become enormously large and hypertrophied. In the face it is often met with ; in the upper extremities rarely.

It is not my intention to enter into an account of the history, symptoms, or causes of this remarkable malady. It is sufficient for my purpose here to say, that the disease appears to be primarily seated in the lymphatics. The glands, as Virchow and Rindfleisch suppose, become impervious to the transmission of lymph, and the hyperplastic deposits that characterize the disease are, together with the general stretching and hypertrophy of the integumental structure, the consequence of the plastic effusion into the areolar tissue.

Treatment.—When this disease attacks the face, little, if anything, avails in the way of treatment. When it affects the labia and scrotum, the diseased part must be removed (see Diseases of Penis and Scrotum). But when the leg is affected, surgery can effect much in the way of cure. In the slighter cases much may be done by elevation of the limb, methodical bandaging, and perhaps, as Rayer and Lisfranc recommended, the employment of scarification. But in the more severe cases, where the limb has swollen to a monstrous size, and has become shapeless from the groin to the ankle, the skin being sallow, covered with nodules and over-laid by branny desquamation, with a tendency to unhealthy and incurable ulcerations, more active measures are necessary.

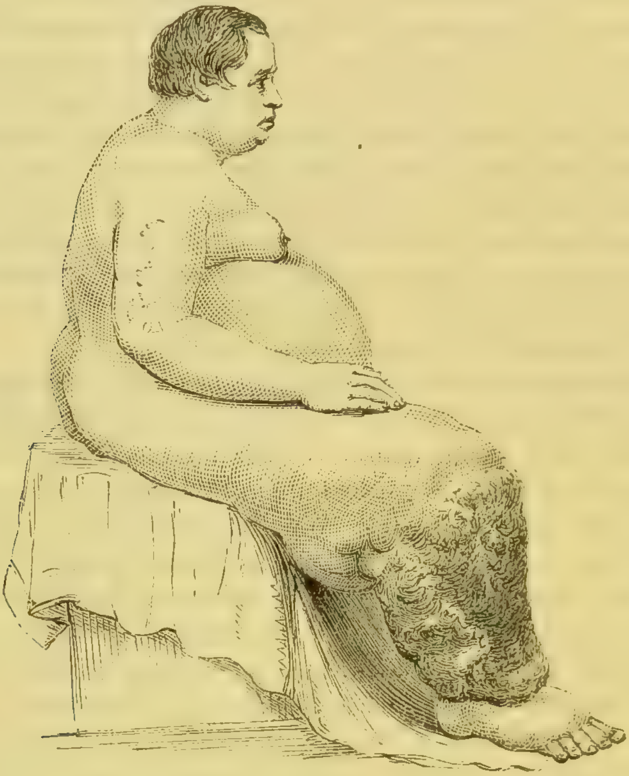

Fig. 425.—West Indian Elephantiasis.

Dufour seems to have been the first to propose diminution of the supply of arterial blood to the limb as a cure for this disease. This he effected by compressing the femoral artery by means of a kind of truss, and he was successful in four cases. This practice of compression has since been successfully followed by Hill, Cockle, Vanzetti, and others.

To Carnochan is due the merit of having recommended the ligature of the femoral artery as a means of cure in these cases; and, in whatever way it acts, there can be no doubt of the excellent effects that have followed this method of treatment, little as it can be explained by the received pathological views as to the disease. In some instances, as by Bryant, Buchanan, and Simon (of Heidelberg), the external iliac has been advantageously tied. The operation on this artery has the recommendation not only of being completely above the limits of the disease, and consequently in parts that are quite healthy, but also of more completely controlling the nutrition of the limb than can be done by ligature of the superficial femoral.

Eppner in 1881 collected the records of 49 cases of elephantiasis treated by ligature of the main artery leading to the diseased part. In 40 of these the femoral was tied; in 5, the external iliac; in 2, the popliteal; in 1, the anterior tibial, and in 1, the brachial. Of these 31 are reported to have been cured, 3 relieved, 1 unrelieved, and 5 died. Of the cases reported as cured 9 subsequently relapsed. The result of the operations appears to have been fairly encouraging, although in a certain number of cases it is evident that little, if any, improvement took place.

LYMPHADENITIS, OR INFLAMMATION OF THE LYMPHATIC GLANDS.

Acute Inflammation of the Lymphatic Glands almost invariably results from the irritation of some noxious material conveyed to them by the lymphatic vessels. The lymphatics through which it passes on its way to the glands may themselves be inflamed, but more frequently they escape. This fact would seem to indicate that in the majority of cases the irritating matter is particulate and not in solution. As we know from experiment solid particles pass readily through the lymphatic vessels without lodging, but are arrested in the lymphatic glands. In every acute inflammation the quantity of lymph passing through the glands in connexion with the affected area is greatly increased. In simple inflammations in a healthy subject this causes slight swelling, which subsides as soon as the cause is removed; but in scrofulous subjects, as before pointed out, there is a peculiar tendency to inflammation of the lymphatic glands from slight causes, and in them the swelling may persist and may pass on to suppuration or chronic inflammation. In infective inflammations the inflammatory products contain the special virus to which the inflammation is due, and this being carried by the lymph-stream to the glands may excite a similar process in them. Most specific inflammations are accompanied by the presence of microscopic organisms of a definite form in the exudations, and in such cases the organisms can frequently be demonstrated by the microscope after death in the lymphatic glands nearest to the seat of the disease. As a rule the secondary inflammation in the glands closely resembles in character that at the primary seat of disease. Thus, in cutaneous erysipelas, the glands are invariably swollen and tender, but seldom suppurate; in soft chancres, suppuration commonly takes place; and in diphtheria, the glands are always enlarged and painful, but pus rarely forms, while in scarlet fever suppuration is often very troublesome. In syphilis, the change that takes place in the lymphatic glands is identical with that occurring at the seat of inoculation; and the same is the case in secondary tuberculosis.

Some infective inflammations, as hospital gangrene and phlegmonous erysipelas, have but little tendency to infect the glands. This is possibly due to coagulation of the lymph in the spaces of the inflamed area.

In the majority of cases there is no difficulty in discovering the source of the irritation which has caused the glands to inflame. In scrofulous subjects, however, the effect may be produced by causes so comparatively slight that their detection becomes proportionally difficult. In some cases it appears to arise simply in consequence of a strain, as in over-walking. In children, the glands are more prone to suppurate from slight sources of irritation during convalescence from measles or some other acute specific disease.

Pathological Anatomy.—Inflammation of the lymphatic glands may be acute, subacute, or chronic. In the *acute* form the gland is swollen, and at first pink in colour and soft. At a later stage yellow points of commencing suppuration will be observed, both in the medullary and cortical part. At a still later period the greater part of the gland may be hollowed out into a cavity filled with pus. The appearances of subacute inflammation are much the same as in the acute. The microscope shows the usual changes observed in all inflammations ; the vessels are distended, and the gland is crowded everywhere with multitudes of small round cells. These very early choke the lymph-sinuses. As these cells exactly resemble the normal corpuscles of the gland, it is impossible to determine whether they are formed by multiplication of the normal lymphoid cells, or have been brought to the gland with the lymph from the inflamed area, or have migrated from the vessels. The capsule and trabeculæ are similarly infiltrated with small cells. The formation of pus takes place in the same way as in other parts. In the less acute forms larger cells are found, formed by proliferation of the flattened corpuscles that cover the trabeculæ and the inner aspect of the capsule. In the more acute forms the surrounding tissues are early implicated in the inflammation.

Chronic Inflammation of the Lymphatic Glands is regarded as the most characteristic feature of scrofula. In it the gland is enlarged often to many times its normal size. In the early stages, it is usually more opaque than natural, and of a grey or dull pink colour. At a later period, yellow points appear, due to caseation. These points gradually increase in size, and coalesce till the whole gland becomes a uniform caseous mass still enclosed in the capsule, which is often considerably thickened. The caseation may terminate the process, the cheesy mass remaining dry and encapsuled without further change. In other cases it is followed by deposit of lime salts, and the diseased gland forms a hard calcareous mass. These formations most commonly occur in the glands of the abdomen and thorax. In superficial glands the caseation is more commonly followed by softening of the cheesy mass, which breaks down into a thick fluid not unlike clotted cream. The softening is accompanied by inflammation, and the slow formation of pus in the tissues round the gland, the capsule gives way at the most superficial part, and the fluid gradually approaches the surface. The chronic abscess thus formed is very slow in perforating the skin, often undermining it for some distance before finding an exit. Microscopic examination of these glands shows in the early stages a great increase in the lymphoid corpuscles, not only in the follicles of the gland, but also choking the lymph-sinuses. Amongst the new corpuscles larger cells are found many times the size of a lymph-corpuscle, and apparently developed from them, as all intermediate varieties are found between the two forms. The flattened cells covering the trabeculæ, and lying on the meshes of the reticulum of the gland, proliferate, and may sometimes be recognized forming a coarse network amongst the lymphoid corpuscles. At first the gland is more vascular than natural, but from the pressure of the accumulated cells the vessels soon become obliterated, and non-vascular areas are formed. At this stage in a very large proportion of scrofulous glands, giant cells surrounded by a zone of larger cells, and again by lymphoid corpuscles, forming thus the anatomical structure of a tubercle nodule, are met with in the non-vascular patches. The caseation commences in the non-vascular spots, and gradually extends. The trabeculæ disappear last in the caseating process. In a large proportion of cases examined up to the present time, the tubercle bacillus has been found in the cheesy glands. In the present state of our knowledge, it is not possible to define accurately the relation of tubercle to chronic glandular inflammation. In those cases in which the disease in the glands is secondary to a tubercular affection of the region from which they receive their lymph, they are probably tubercular from the beginning. In other cases the chronic inflammation may be antecedent to and a predisposing cause of the development of tubercle; and again it is possible that chronic inflammation followed by caseation and softening may take place without the process being at any time tubercular. The softened caseous product of chronic inflammation of the lymphatic glands has long been believed to be a source of general tubercular infection, the fine granular débris entering the circulation and lodging in distant parts, and there causing the growth of tubercle. Koch's discovery of the bacillus of tubercle, showed that in these cases the bacilli or their spores are the actual infective material. This general infection when it does occur is however merely an accidental occurrence, the vast majority of patients who suffer from caseating lymphatic glands escaping with nothing more than the local disease.

Induration of the gland, due to thickening of the trabeculæ and capsule, and of the meshes of the retiform connective tissue, is not an uncommon result of slight degrees of chronic inflammation.

In whatever way occurring, inflammation of the lymphatic glands always causes obstruction to the flow of lymph through them, and if the whole or greater part of the glands of a limb be affected, œdema, often of a solid character, may occur in the parts from which they receive their afferent lymphatic vessels.

Symptoms.—In **Acute Lymphadenitis** there are pain, swelling, and tenderness, and stiffness about the affected glands, with a dull heavy sensation in them. The outline of the swollen gland is at first clearly defined, but soon becomes concealed by the inflammation extending to the contiguous areolar tissue. Before long redness, œdema, and the other signs of acute abscess make their appearance. In **Subacute Lymphadenitis** the glands become swollen, enlarged, and tender, and are matted together by inflammatory exudation into the surrounding tissues. If abscess form, it frequently commences in the structures around the glands; and those are perhaps eventually exposed at the bottom of the cavity that results. This is especially apt to happen in cachectic and strumous persons from slight sources of irritation. Very commonly in such subjects the inflammation of the glands runs into a chronic state. **Chronic Lymphadenitis** or **Strumous Enlargement of the Lymphatic Glands** may arise as a sequence of subacute inflammation, but more commonly the glands gradually enlarge without marked pain or tenderness in consequence of chronic irritation of some kind. It is not possible to make any accurate distinction clinically between simple chronic inflammation, strumous enlargement, and tubercular disease. Chronic inflammation of the glands is commonly looked upon as the most marked characteristic of the strumous diathesis, and the relation of the process to tubercle has been already sufficiently discussed. These changes occur principally in children and young people, and most frequently in the neck, especially in the submaxillary glands and the glandulæ concatenatæ, and sometimes in the axillary and inguinal glands. The glands slowly increase in size, at first remaining clearly defined and distinct from each other. They may after a time cease to enlarge, and remain permanently without further change, but more commonly after continuing in this state for months or years they soften. The inflammation then extends to the surrounding tissues, and the glands become adherent to neighbouring parts, and finally to the skin. Several glands may thus become fused together, forming a large indurated and nodulated tumour. Suppuration takes place slowly, and the skin becomes thin, blue, and undermined. Finally, it gives way by a small opening, and curdy unhealthy pus is discharged, mixed with the débris from the softened cheesy matter from the gland. The discharge may continue for weeks or months, being kept up partly by the gradual expulsion of the remains of the degenerated gland, and partly by the thinned and undermined skin being too feeble to take any part in healthy repair. The opening may close for a time, bursting open and discharging again at intervals. In other cases the thinned skin perishes, and the remains of the gland may be exposed as a reddish-grey or fleshy mass protruding in the midst of the sore. When these sores finally heal, they leave thin blue cicatrices ultimately forming irregular puckered scars.

Treatment.—The local treatment of inflamed lymphatic glands varies according to the nature of the process. In all forms the local irritation to which the inflammation is due must be removed if possible. In *acute lymphadenitis* the application of glycerine and extract of belladonna in equal parts, and hot fomentations may prevent suppuration. In the *subacute* condition, spirit lotions containing iodide of potassium will sometimes subdue the inflammation and take down the swelling. If an abscess form, it must be freely opened and the part dressed with some antiseptic application. The sinuses which are often left when the abscess is imperfectly opened, or allowed to discharge by itself, require to be treated by stimulating applications, especially the nitrate of silver ; but very commonly they will not heal unless they are laid open and dressed from the bottom.

Chronic or Scrofulous Inflammation of the Lymphatic Glands, requires to be treated on different principles. When there is merely chronic enlargement, without irritation, methodical friction with iodine or iodide of lead ointment will sometimes produce absorption of the inflammatory products, constituting the bulk of the enlargement ; and this in some instances may remove the tumour entirely. In other cases painting the part with tincture of iodine, and improvement of the general health, will cause the removal of the disease. When the gland has softened and is becoming adherent to the surrounding parts, it becomes an important question at what period it should be opened, so as to ensure the speediest recovery and the least scarring. It was formerly advised by many Surgeons to leave the gland until it became distinctly adherent to the skin, and until it was so completely softened that the whole of the cheesy matter might be discharged at the time of opening. The result of this plan was usually to leave a deep puckered scar, and healing was seldom complete for some weeks or even months. These unpleasant consequences can be to a great extent averted by early opening, and free scraping with a sharp spoon (Fig. 99, Vol. I.). As soon as the gland is evidently softening the operation may be performed. The gland is steadied between the finger and thumb of the left hand, and a puncture made into it with a scalpel about a quarter of an inch in width. A probe may then be passed along the scalpel, so as to serve as a guide to the opening in the capsule. The scalpel is then withdrawn, and a small sharp spoon passed along the probe into the gland. By forcibly squeezing the gland and scraping with the spoon, the whole of its caseous contents can usually be removed without difficulty. A very fine drainage-tube may then be inserted for a few days, after which healing will probably take place without difficulty. The results of this little operation are very much better if strict antiseptic precautions are observed; for if the cavity becomes filled with decomposing discharges, troublesome diffuse suppuration may follow in the areolar tissue. Iodoform- or salicylic-wool forms the best dressing in most cases. If several glands lie close together, it is sometimes possible to scrape more than one from a single opening in the skin. The scars left after this mode of treatment are very slight.

If an aperture already exists leading down to an indurated mass, the sinus may be freely scraped in the same way, and healing is often hastened by the insertion of a small quantity of iodoform into the track left after the operation. If after an abscess has formed and been opened, an irregular cavity is left with masses of degenerating gland-tissue projecting into it, these may be scraped away with a sharp spoon, or destroyed by potassa fusa. In applying the caustic potash, care must be taken that its action do not spread too widely; this may usually be avoided by coating the surrounding integuments with collodion. The blue undermined skin left after spontaneous bursting of a scrofulous abscess of the glands delays healing, and is itself useless for any purposes of repair. It must therefore be destroyed, however large the resulting sore may at first appear to be. This may be done by means of potassa fusa, but cutting it with scissors in a number of lines radiating from the central opening will usually make it in great part melt away, and at the same time is free from the risk of destroying more than is necessary.

Extirpation of chronically inflamed and caseating lymphatic glands has been recommended with the view of preventing general tubercular infection; but it is not to be recommended for this reason alone. It is impossible in the vast majority of cases to remove all or nearly all the affected glands, and if undertaken, it may lead to more serious and extensive dissections than might at first appear requisite; for a chain of diseased glands often extends a considerable distance, and after one has been removed, others come into view. Cases, however, occasionally occur, in which such a procedure may be deemed advisable, the affected glands being large and indurated, and the disease of many years' standing; their extirpation may then be proper, and I have not unfrequently had occasion in such circumstances to remove them from the axilla, from the submaxillary region, and from the posterior triangle of the neck.

The constitutional treatment of chronic strumous disease of the glands is fully described in the Chapter on Scrofula and Tubercle, Vol. I., p. 1082.

LYMPHADENOMA.

This disease has already been described in the Chapter on Tumours (Vol. I., p. 991), and but little remains to be said concerning it. When the disease is limited to the lymphatic glands, the question of their removal often comes before the Surgeon.

If the tumour be large and single, or composed of an agglomeration of multiple masses, and so situated that it can be taken out with safety, its removal is proper, and should be practised. I have several times removed large lymphadenomata from the axilla and upper part of the neck with great advantage. Even when the disease is multiple, single large masses that are sources of special trouble should be dissected out. In one such case a tumour, which was as large as a fist, was removed, in University College Hospital, from the axilla. The patient, a delicate woman, had a group of similar growths in the neck, which had remained stationary for twenty years.

The operation should not be undertaken when the patient is very weak or anæmic, and more especially when there is persistent elevation of temperature.

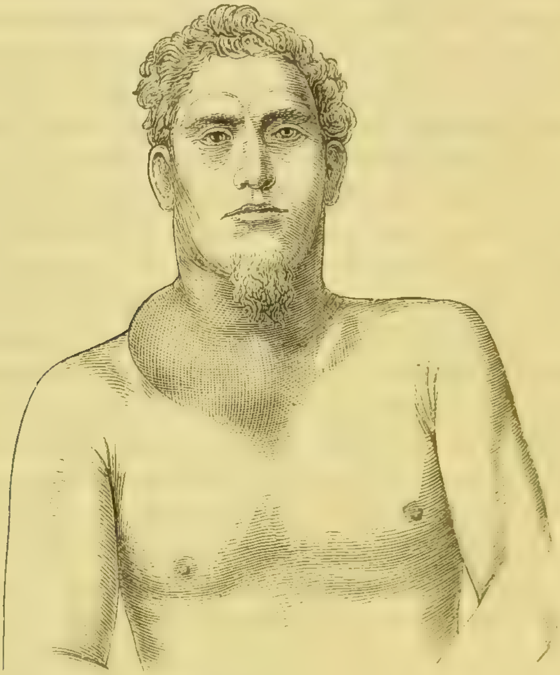

Fig. 426.—Lymphadenoma of Glands at Root of the Neck.

The accompanying figure (Fig. 426) from a patient under the care of Christopher Heath is a good illustration of the appearances produced by this disease when affecting the glands at the root of the neck.

With the exception of lymphadenoma, the lymphatic glands are singularly exempt from the growth of primary tumours. Round-celled sarcoma is said to be occasionally met with, but it is probable that some of the tumours formerly described under that name would now be classed as lymphadenomata. Secondary tumours are, however, extremely common. All forms of cancer tend to affect the glands at an early period of their growth. Round-celled and melanotic sarcomata also frequently give rise to secondary tumours in the glands.

CHAPTER XL.

DISEASES OF VEINS.

VENOUS THROMBOSIS.

THROMBOSIS or coagulation of the blood in the vessels during life is very common in the veins.

Causes.—The exact nature of the process of coagulation of the blood is still far from being fully understood. The view generally entertained at the present time is that fibrin does not exist as such in the blood, but is formed from two substances, fibrinogen and fibrin-ferment. The fibrinogen is contained in the blood-plasma in solution. The fibrin-ferment is not supposed to be present in a free state in the blood as it circulates in the body, but is liberated from some of the colourless corpuscles under certain conditions. Blood, in contact with the walls of vessels, which, to use Cohnheim's expression, are in a state of "physiological integrity," shows no tendency to coagulate, but when it is brought in contact with dead matter clotting takes place. In the same way, if the integrity of the vessels is damaged by disease or injury fibrin becomes deposited at the damaged spot. The presence of free ferment in the blood may also cause coagulation in the living body. Köhler has shown that if a sufficient quantity of fibrin-ferment be experimentally introduced into the blood-stream, rapid coagulation will take place, even in contact with healthy vessels. If a smaller quantity is injected there is severe febrile disturbance, but thrombosis does not take place, the influence of the healthy walls of the vessels being then supposed to be sufficient to arrest coagulation until the ferment is eliminated from the blood. Other substances have been shown to be capable of causing extensive coagulation in the living vessels. Thus Wooldridge states that a phosphorized fat known as lecithin, which may be obtained from the lymphatic glands, testis, brain, and other tissues, causes rapid coagulation and death from cardiac thrombosis if injected into the blood-stream. On the other hand, if peptones be injected into the blood-stream during life blood drawn shortly afterwards fails to coagulate. These observations show that the coagulability of the blood may be directly influenced by the admixture of various foreign substances with it.

Retardation, or arrest of the blood-stream, acts as a powerful predisposing cause of thrombosis. These conditions apply equally to all vessels, whether arteries, capillaries, or veins, but we have to consider them here in reference to the veins only.

The causes of venous thrombosis may be thus classified :—

1. Changes in the condition of the wall of the vessel due to (*a*) injury ; (*b*) inflammation ; (*c*) degeneration.

2. Altered conditions of the blood in which there is supposed to be a liberation of the ferment.

3. Retardation or arrest of the blood-stream; due to (*a*) diminished *vis a tergo;* (*b*) pressure on the vessel; (*c*) interruption of its continuity; (*d*) obstruction by a thrombus due to any of the preceding causes.

1. **Changes in the wall of the vessel.**

a. Injury.—The effect of any severe injury to the coats of a vein is either to extinguish, or so far to diminish, the vitality of the injured part, that it behaves towards the blood as a foreign body, and a coagulum is formed on the damaged part just as it would be on a piece of wire introduced into the vein. A vein is occasionally penetrated by a foreign body, as when a ligature is accidentally passed through it in ligaturing a contiguous artery. Under these circumstances a clot will quickly form upon the foreign body.

b. Inflammation.—It has already been pointed out in the Chapter on Inflammation that the most essential feature of the process is a diminished vitality of the affected part to a degree short of actual death. If the inflammation is sufficiently intense the wall of an inflamed vein behaves towards the contained blood as if it were dead matter, and coagulation consequently takes place. Thrombosis thus forms a marked feature of all forms of phlebitis. The causes of inflammation of veins will be described later on (see Phlebitis).

c. Degeneration.—Degeneration of the coats is less marked in the veins than in the arteries. In varicose veins, the middle coat is greatly thickened by the growth of fibroid tissue, and calcareous plates are sometimes met with in it; but the endothelial lining is usually intact, and consequently thrombosis comparatively rarely takes place as a consequence of this alone.

2. **Altered Conditions of the Blood.**—The exact nature of the changes of the blood that predispose to thrombosis is very imperfectly known. The experiments before alluded to show that an excess of free ferment in the blood may act as a powerful predisposing cause, or even the sole cause of coagulation. In septicæmia, pyæmia, and many other acute febrile diseases, there is considerable destruction of corpuscles, and very probably in this way ferment is liberated, and it is well known that thrombosis is common in these affections. The mere excess of white corpuscles, such as is observed in leucocythæmia, does not seem to predispose in any great degree to thrombosis. Koch has observed, in pyæmia experimentally induced in animals, thrombosis of small vessels apparently originating in the plugging of the channel by microscopic organisms, and possibly some such condition may be present in some cases of venous thrombosis.

3. **Retardation of the Blood-stream.**—Perfect rest of the blood when withdrawn from the body delays coagulation, and free movement hastens it. It is impossible, therefore, to suppose that retardation or arrest of the flow can act directly as a cause of thrombosis. Nothing, however, is more certain than that it does form one of the most important causes of coagulation in the living vessels. It may act in various ways. First, if the arrest of the circulation be complete and of sufficient duration, the vitality of the part will suffer until the vessels come to act as foreign bodies and coagulation takes place. Secondly, if a part of the vein is already diseased or injured the retardation of the blood-stream will favour the adhesion of the white corpuscles to the unhealthy surface, which is the first step in thrombosis when the blood is still moving. Thirdly, if the blood stagnate for a sufficient time the white corpuscles may perish from want of oxygen and disintegrate,

thus liberating the ferment and inducing coagulation. Lastly, it is possible that the nutrition of the endothelium may suffer from arrest of the flow of blood through the vessel even when the circulation through the surrounding tissues is sufficiently active to maintain their vitality.

Retardation or arrest of the blood-stream may arise (*a*) from diminished *vis a tergo*. This may be due to want of power in the heart from old age, bad nourishment, exhausting fevers, or from shock or loss of blood from injury or operation. Interruption to the proper distribution of the force through want of elasticity in the arteries acts in the same way. Obstruction of the main artery of a limb or arrest of the capillary circulation in the area from which a vein derives its blood, will in like manner retard the venous flow. Another very common cause of retardation or arrest of the blood-stream in the veins is the obstruction caused by the pressure of a tumour, or the contraction following chronic inflammation of the connective tissue of an organ; examples of these conditions may be frequently seen in the iliac veins pressed upon by a pregnant uterus or an ovarian tumour, and in the vessels of a cirrhotic liver; and it must be remembered that a tight bandage may act in the same way.

When a vein is divided in a surgical operation, it empties itself and becomes collapsed as far as the next pair of valves, but above these it may remain full of stagnant blood up to the point at which another vein enters the trunk. When a vein is ligatured in its continuity there will be, in addition, stagnation of blood below as far as the next collateral branch.

When the circulation is too feeble to press the valves back against the walls of the vessel, or when in consequence of dilatation they are never properly closed, but project into the lumen of the vein, it not uncommonly happens that stagnation takes place in the sinuses of the valves, and small thrombi may thus form, which finally project into the lumen of the vessel, and by gradual increase may at last close it completely.

The Process of Thrombosis.—Thrombosis may take place while the blood is moving, the lumen of the vein becoming gradually filled with the coagulum, or while the blood is at rest.

The appearance of the thrombus varies with the conditions under which it is formed, much as the coagulum obtained by whipping blood differs from that formed when freshly shed blood is allowed to coagulate undisturbed in a vessel. The process of thrombosis has been observed experimentally by Zahn in the veins of the mesentery and tongue of the frog. A large vein being chosen, its walls were injured by placing a crystal of common salt near or directly over it. On watching the injured spot, the white corpuscles of the passing blood were seen to adhere to it until they were heaped up, sometimes to such an extent as completely to obstruct the vein. If the caustic action of the salt had not been very severe they might break loose again and pass away into the blood-stream; if it had been more powerful the corpuscles remained adherent. After some hours they were seen to undergo a marked change. The greater part disintegrated, their outline being lost and their nuclei no longer being recognizable, and a fine granular mass, having the appearance of freshly-formed fibrin, appeared in the place they formerly occupied. This observation is in harmony with the view that the liberation of the ferment by disintegration of the white corpuscles plays an important part in the process of coagulation. The thrombus thus formed was in some cases pure white in colour, but more commonly a few red corpuscles were entangled amongst the white. The more rapidly the plugging of the vessel took place the more red corpuscles were entangled in the thrombus. When coagulation takes place in a vessel in which the flow is completely arrested the clot differs in no respect from that formed in blood drawn from the body. It entangles in its meshes all the corpuscles, both red and white, and presents the familiar dark red colour.

These observations explain the different appearances of the thrombus under the different circumstances in which thrombosis takes place. The clot formed above an injury which completely obstructs a vein, as when it is divided or tied, is uniform in structure, dark red in colour, and at first but loosely adherent to the inner coat of the vessel. At a later period, as in the case of a ligatured artery, it becomes denser in consistence from contraction, and more firmly adherent, and loses its colour in consequence of disintegration of the red corpuscles. A thrombus formed by gradual deposit from the circulating blood upon the unhealthy walls of a vein is either white or mixed in tint, according to the rapidity with which it is formed. It is firmly adherent to the inner coat of the vein and laminated in structure. Microscopic examination shows it to contain few red disks, but numerous white corpuscles which have escaped disintegration are usually found between the laminæ.

As a rule the thrombi arising in cases in which an altered condition of the blood is supposed to be the cause of coagulation are white or mixed, the fibrin being deposited gradually on the walls of the vein, starting from some point where from disease or injury the endothelium is damaged.

When a vein is completely obliterated by a white thrombus, the stagnant blood on each side coagulates, forming a red clot adherent to the white. After death a further extension of this red clot takes place. These *post-mortem* clots are recognized by their softness and by their floating free in the vessel.

Cornil and Ranvier have supposed that in many cases at least the central portion of a laminated clot, and not its peripheral layers, are the oldest, the fibrin having been first deposited on the wall of the vein and then separated from it by contraction, though prevented from passing on towards the heart by the prolongations extending into the collateral branches. This view, however, seems far from probable. The only appearance suggesting such a process is met with in the clots extending from the heart into the pulmonary artery in cases of cardiac thrombosis. These are commonly found to fill the vessel incompletely, and often present perfect casts of the pulmonary valves. In these cases, however, the coagulation takes place immediately before death, and very probably the contraction is *post-mortem.*

The **Fate of the Thrombus** varies according to the circumstances in which it is placed and the causes of its formation. Thrombi arising from injury undergo the same changes as those forming in arteries under similar circumstances (Vol. I., p. 411). The restoration of the channel through a vein, when the continuity of its walls has not been interrupted, takes place more readily than in similar conditions in the arteries. It is possible that in some cases this may result from disintegration of the clot, the débris being carried away and lodged in the lungs, where, if non-infective in character, they would cause no serious symptoms. The normal process of restoration, however, is effected by the clot becoming infiltrated by new cells proceeding from the wall of the vessel, as in the permanent closure of a divided vein.

New vessels afterwards penetrate amongst these cells, and by means of these a communication is established between the permeable portions of the vein above and below the clot. The channel, at first small, gradually enlarges by absorption of new tissue through which it passes, and thus, at last, the full calibre of the vein is restored.

Softening and Disintegration are common changes when the thrombus has been formed in consequence of inflammation of the vein, or as a result of those altered conditions of the blood which accompany septicæmia or malignant fevers. It is a very frequent occurrence when the affected vein leads from a wound the discharges of which are in a septic state, or from an area affected with some infective inflammation, as in acute necrosis of bone.

Softening most commonly takes place in white or mixed thrombi. It commences in the centre of the clot at the part furthest removed from the walls of the vein. The clot if mixed becomes completely decolorized, and gradually breaks down into a creamy fluid resembling pus in appearance. Microscopic examination, however, shows that it is not pure pus. In some cases it is composed merely of granular débris, no corpuscles of any kind being recognizable ; in others a certain number of pus cells may be mixed with the débris. These are white corpuscles, which were either contained in the clot and have escaped disintegration, or have wandered into it from the surrounding parts. In most cases in which softening takes place, micrococci are found in abundance in the puriform fluid. The effects of the process of softening will be discussed immediately.

Calcification of a Thrombus is of rare occurrence. It occurs chiefly in the small clots that form in varicose veins in the pouches behind the valves. These calcified clots form small rounded bodies, varying in size from a mustard seed to a pea, and are known by the name of phleboliths.

Effects of Thrombosis.—The first effect of thrombosis when not arising from obstruction is necessarily to arrest the flow of blood through the vein. If a single superficial vein be obstructed, this may cause no marked symptoms ; but when the clot is situated in a main trunk, as in the femoral at the groin, it causes great œdema of the parts below. This is commonly seen in the so-called " white-leg," which occurs after labour. If the vein remain permanently obstructed, the œdema may subside after some weeks or months, the collateral veins gradually dilating, and the free return of blood being thus re-established. In other cases the œdema diminishes, but does not completely disappear, the limb swelling considerably when in a dependent position. When this occurs, the areolar tissue is indurated, the œdema becoming more " solid " as time goes on. The nutrition of the parts is interfered with, and chronic eczema or ulceration of the skin from slight causes is not uncommon.

The relation of thrombosis to inflammation of the vein is a subject on which there has been considerable difference of opinion. Pathologists in the early part of the century regarded the presence of a thrombus in a vein, except when obviously due to mechanical causes arresting the flow of blood, as evidence of previous inflammation of the coats of the vessel. Some later pathologists on the other hand have maintained that when thrombosis is found associated with inflammation of the coats of a vein, the latter condition is always secondary to the former. The truth probably lies between the two views. A vein may become inflamed as the result of mechanical violence, or of being laid bare in an operation and subsequently exposed to the contact of decomposing discharges, or by being implicated in unhealthy ulceration of the surrounding structures. In other cases diffuse inflammation may spread from a septic wound in the loose areolar tissue surrounding the vein. In all these conditions the phlebitis precedes the thrombosis. The opposite condition may be met with when a vein has been wounded, and its divided end filled with a clot is exposed in a septic wound. The clot then becomes impregnated with septic matter, and fresh coagulation takes place upon its proximal extremity ; septic disintegration of the clot follows, and the coats of the vein become inflamed from the contact of the irritating products of the process. Thus a spreading thrombosis, followed by disintegration of the clot and inflammation of the vein, may be set up. This is a condition frequently met with in pyæmia, and is especially common in the infective inflammation of bone known as acute necrosis. In some cases of pyæmia, thrombosis, with softening of the thrombus and inflammation of the coats of the vein, is met with in parts having no connexion with the original wound. Here also it is only reasonable to suppose that the irritating properties of the thrombus are due to the presence of the infective material in the blood from which it is formed. Simple coagulation of healthy blood in a vein does not cause acute inflammation of the coats of the vessel. After the operation for varix the vein can often be clearly felt on each side of the obliterated spot as a solid cord, but none of the signs of phlebitis are present.

The most serious consequence of venous thrombosis is *Embolism*, or the separation of a clot, and its entry into the circulation. When the formation of the thrombus has been due to mechanical injury, this complication rarely takes place. Occasionally, however, after a surgical operation or parturition, a large clot may be dislodged and cause sudden death by obstructing the pulmonary artery. If the clot is not large enough to obstruct the main trunk of the artery, it may lodge in a smaller branch and recovery may follow. The following is a typical case of this kind. A man, aged 59, had been confined to bed for some weeks with a compound dislocation of the ankle ; the wound was nearly healed, and he was apparently in good health. He suddenly woke from sleep with a violent pain, which seemed to shoot up from his leg to his chest. There was immediately intense sense of dyspnœa, although the air entered the lungs freely ; the pulse rose to 120, and the action of the heart was violent and irregular. The symptoms gradually subsided, and on the third day after the attack he expectorated a small quantity of blood. Within a few hours of the attack, the symptoms of obstruction of the femoral vein manifested themselves. It was slightly tender, and could be felt as a hard cord, and great œdema of the limb appeared. Some weeks after the veins of the opposite limb became plugged in the same way, but no embolism took place.

Embolism is more commonly the result of softening and disintegration of the clot. It is possible that a healthy clot may in this way be removed without giving rise to any definite symptoms. When the softening is due to the septic changes in the thrombus, or when the clot is impregnated with the products of an infective inflammation of any kind, the virulent fragments set up inflammation wherever they lodge, giving rise to the form of general infection known as embolic pyæmia. The pathological effects of simple and infective embolism have been already described (see Pyæmia, Vol. I., p. 976).

A softening thrombus does not necessarily give rise to embolism. In the common form of so-called idiopathic phlebitis, suppuration frequently takes place round the thrombosed vein, the middle part of the thrombus is softened, the walls of the vein give way, and the débris of the clot are discharged with the pus of the abscess. In these cases a portion of the thrombus on each side remains unsoftened, and undergoes the ordinary changes observed in closure of a divided vessel.

The **Symptoms** of thrombosis are merely those of obstruction of the vein. If superficial, the vein can be felt as a hard cord, with knot-like projections at the situations of the valves. If a deep vein is affected, there is œdema of the part from which it comes, often with dilatation of the superficial veins. The swollen parts are white, and pit deeply on pressure. When the coats of the vein are inflamed, the symptoms of phlebitis to be presently described will be manifest.

The **Treatment** of venous thrombosis depends entirely on the cause. When it is a part of the pyæmic process, no special treatment is of much service; when associated with phlebitis, it must be treated as described under that disease. Œdema must be treated by elevation of the limb and careful bandaging with an elastic or stocking bandage. In all cases perfect rest of the part must be maintained in order to obviate as far as possible the risk of embolism.

PHLEBITIS.

INFLAMMATION OF THE VEINS, originally studied by Hunter, has in later years attracted the attention of many distinguished Continental and British pathologists, amongst whom may be specially mentioned Breschet, Velpeau, Cruveilhier, Arnott, Henry Lee, Tessier, and Virchow.

Causes.—Phlebitis may arise from injury of the coats of the vein, from inflammation of the tissue surrounding it (periphlebitis) or from the formation of an unhealthy thrombus within it. Each of these causes may occur separately, but frequently more than one are concerned in the process. In other cases phlebitis is said to be idiopathic, which means that the cause cannot be accurately ascertained.

Traumatic phlebitis may be simple and localized, or septic and spreading. The coats of a vein, in the same way as any other tissue, become inflamed if subjected to any injury of sufficient intensity, whether it be the application of a ligature in a surgical operation, accidental mechanical violence, or the action of caustics. As the result of the injury, a clot forms within the vein, adherent to the damaged spot. If this completely occludes the vessel, it extends upwards and downwards as far as the blood in the vein is stagnant. The inflammation is however limited to the injured spot, and shows no tendency to extend. Ultimately the clot may become absorbed, and the channel of the vein restored, or the vessel may become permanently obliterated by the processes already described as occurring in arteries under similar circumstances.

Traumatic phlebitis does not however always run this simple course. When the discharges of the wound through which the vein has been injured are in a septic condition, and the plugged vein is exposed to the direct contact of putrid matter, the thrombus may become infected. It then softens and decomposes, and thus excites inflammation in the coats of the vein, spreading beyond the part originally injured. Fresh clot, which in its turn decomposes, forms in the vein as far as the inflammation extends; and so the process may spread until some part is reached at which a large vein joins the affected trunk, when fragments of the softening clot are washed on, giving rise to the dissemination of septic emboli and pyæmia. It is this form of spreading phlebitis that was formerly so common in hospital practice. The earlier pathologists regarded the spreading inflammation of the vein as the primary cause of the mischief, whereas it is evident that it is really due to the changes taking place in the thrombus.

Spreading phlebitis may arise also without an injury in the veins leading from many infective inflammations. Either the trunk may be involved in the inflamed area or thrombosis may extend into it from the smaller veins and venules. In either case the clot becomes impregnated with the infective material, and undergoes changes of the same character as those just described.

In some cases of pyæmia or septicæmia, thrombosis may occur, as has been already pointed out, in parts distant from the seat of infection, and in these cases it softens and causes inflammation of the coats of the vessel. It is a possible explanation of this phenomenon that the blood contains before coagulation some noxious material, which causes the subsequent softening and disintegration. In support of this theory is the fact that micrococci are found abundantly in the débris of the broken down clot.

Diffuse inflammation spreading from an unhealthy wound along the areolar tissue surrounding a vein may, in some cases, give rise to inflammation of its coats and thrombosis.

In addition to the above forms of the disease, phlebitis is frequently met with without our being able definitely to explain its mode of origin, and it has therefore been said to be idiopathic. This form almost invariably affects one of the large veins of the lower extremity, usually the saphena, but occasionally the popliteal, femoral, or iliac. Most commonly the vein attacked has long suffered from varix. It seems to be most frequent when erysipelas is epidemic, but the relation between the two affections is not proved. The inflammation extends to the surrounding areolar tissue, and may occasionally, though rarely, end in suppuration. The clot then disintegrates, the walls of the vein give way, and the débris mix with the surrounding pus; but even when this happens, there is but little tendency to extension of the mischief, the disintegrating clot being shut off on each side by an adherent unsoftened thrombus. When suppuration does not follow the risk of disintegration and embolism is very slight, but it does sometimes occur and causes death.

Sir James Paget has pointed out that "idiopathic" phlebitis commonly affecting the long saphenous, but occasionally the deeper veins, is not uncommon in gouty subjects. It may occur in different parts of the same vein at the same time, and is very liable to relapses. He has termed the affection "gouty phlebitis," and believes that it commences as a gouty inflammation of the coats of the vein.

Pathological Anatomy.—The coats of an inflamed vein are swollen and rigid, and of a redder tint than natural from injection of the vessels of the outer coat. The surrounding tissues are usually œdematous. In septic or infective phlebitis the walls of the vein are softened, and often give way opposite the disintegrating portions of the clot; and wherever this happens a collection of pus forms outside the vessel. The conditions of the thrombi in inflamed veins have already been sufficiently described (see Venous Thrombosis). Microscopic examination shows the coats of the vein to be infiltrated with small round cells ; the endothelium is at first swollen, and if softening of the thrombus takes place, is lost in the disintegrating clot.

Symptoms.—In idiopathic or gouty phlebitis of a superficial vein the symptoms are very evident. The patient has usually suffered from varicose veins before the attack. The inflammation is localized, usually affecting a few inches of the vessel, and sometimes two or more parts at the same time. The vein becomes hard, swollen, knobbed, and painful, the knobs constituting distinct enlargements opposite the valves, or in the pouch-like dilatations of the varicose vein. The skin covering it assumes a reddish purple colour, and there may be stiffness, or inability to move the limb. There may perhaps be no pain when the limb is at rest, but in some cases there are severe shocks of pain, resembling neuralgia, darting along the line of the vein. In all cases there is acute tenderness over the course of the vessel. There is always some œdema around the inflamed vein, but if a single superficial vein is affected there is but little swelling of the parts that supply it with blood, owing to its free communications with the deep veins.

When the deep veins are affected the most marked signs are deep-seated acute pain and tenderness, with marked œdema of the parts from which the vein derives its blood. This œdematous condition of the limb is a most important diagnostic sign of deep-seated phlebitis when the vein cannot be felt (as in the pelvis for instance), and may be the first symptom observed, coming on either suddenly or gradually. The œdema may give rise to a hard, white, tense condition of the limb, which pits on pressure, though in some cases the hardness is too great for this, as is seen in the ordinary "white leg" of the accoucheurs. Occasionally in deep phlebitis the limb may suddenly swell to a considerable size without there being any subcutaneous œdema. In phlebitis of the deep veins of the leg and thigh, the calf of the affected limb may suddenly enlarge, with great pain and much distension of the superficial veins with fluid blood, but without any subcutaneous œdema. As the inflammation subsides the pain and tenderness disappear ; and if superficial, the distended vein, with its solid contents, becomes more clearly defined. In varicose veins complete obliteration of the vessel may take place, the hard cord gradually diminishing in size till it is no longer perceptible. If the deep-seated veins are affected the œdema continues long after the signs of inflammation have disappeared, perhaps for many months, till either the channel of the vein has been restored or the superficial veins have enlarged sufficiently to carry back the blood without difficulty. If suppuration takes place in phlebitis of a superficial vein, the symptoms are those of an ordinary acute abscess. When the deep veins are affected, the symptoms are less clear until the accumulation becomes of sufficient size to give a distinct sense of fluctuation. In these cases there is but little fear of pyæmia, as the vein is closed by a firm adherent clot on each side of the part in which suppuration is taking place. After the resulting abscess has been opened, however, spreading septic phlebitis, followed by pyæmia, may occur unless proper antiseptic precautions are taken to prevent it. The constitutional disturbance in the form of phlebitis is not severe unless suppuration takes place, and even then it speedily subsides as soon as the pus is evacuated.

The symptoms of *spreading septic phlebitis* of the deep veins are less evident, being concealed more or less completely at first by the unhealthy inflammation taking place in the part from which the mischief has started, and later on by the grave constitutional symptoms of pyæmia which speedily manifest themselves. Pain and tenderness in the line of the vein, with considerable œdema rapidly coming on, would lead to a suspicion of its occurrence. The superficial veins are less commonly affected, but should they be implicated, the symptoms are those just described of superficial phlebitis, differing only in the steady extension of the redness and pain up the course of the vein, and in the presence of the general symptoms of blood-poisoning.

Treatment.—The first point to be attended to in the treatment of phlebitis is absolute rest of the limb in an elevated position. The importance of rest in these cases is twofold; first, to prevent pain and increase of the local mischief; and secondly, to guard against the danger that may result from the detachment of the thrombus, which, carried into the circulation, may occasion sudden death by plugging of the pulmonary artery, or more remotely, in cases of septic phlebitis, by pyæmia.

In simple or gouty phlebitis, much local comfort is derived from the application of Extract of Belladonna and Glycerine, in equal parts, covered by a thick layer of cotton-wool and a bandage. Should this application not be at hand, hot fomentations will afford great relief. The constitutional treatment must be conducted on ordinary medical principles in accordance with the age and strength of the patient, depletory measures always being avoided, and early recourse being had to a tonic or stimulating plan. The hardness that is often left after the subsidence of the inflammation will gradually disappear without any special treatment. If œdema of the limb continue, the pressure of an elastic roller will remove it. But if the œdema has been extensive and chronic the limb rarely, if ever, completely recovers its natural size.

If abscesses form they must be treated by free and early incisions, the most scrupulous attention being paid to the prevention of decomposition.

In spreading septic phlebitis treatment is of little avail. If a superficial vein is affected it would be justifiable to expose the vein above the affected part and remove a portion of it to arrest the progress of the disease. If the deep veins are affected and the diagnosis can be clearly established, and especially if rigors and other symptoms of blood-poisoning are present, amputation may give the patient a last chance. This form of phlebitis is, however, almost certainly preventable by any efficient antiseptic mode of treating wounds.

In those cases in which a similar condition is set up in the vein leading from an area of infective inflammation, not septic in character, as in acute necrosis of bone, the diagnosis is almost impossible until it is too late for amputation to be of any service.

VARICOSE VEINS OR VARIX.

By Varicose Veins or Varix is meant a permanent dilatation of the veins with thickening of their walls. It must be distinguished from simple dilatation or phlebectasis such as arises from acute obstruction to the return of blood, or from the pressure of a tumour or aneurism. Simple dilatation subsides as soon as the cause is removed, and it is not accompanied by any definite change in the structure of the walls of the veins ; varix is permanent, and is always associated with degenerative changes in the coats of the affected vessel.

Causes.—The causes of varix are generally *such conditions as induce more or less permanent or frequently repeated distension of the veins.* Thus, for instance, strains and habitual over-exertion of a limb, by driving the blood from the deep into the subcutaneous veins, may give rise to their distension ; so also sedentary occupations and prolonged standing tend to favour accumulation of blood in the veins of the lower extremities. Any obstacle to the return of blood from a vein (as the pressure of a tight garter below the knee, or of a tumour upon one of the large venous trunks), may give rise to permanent distension if it act for a sufficient length of time. When the vein has become sufficiently dilated to render its valves incompetent, the tension of the walls of the veins is greatly increased by the weight of the unbroken column of blood, and the condition thus becomes aggravated. In all cases in which the tissues are congested from any obstruction to the return of blood to the heart, the walls of the veins suffer with the other parts, and are thus rendered more prone to undergo degenerative changes.

In some cases the affection, or the disposition to it, appears to be *hereditary;* and in many instances it is difficult to recognize any cause except an *enfeebled and relaxed state of the walls* of the vessel, such as is met with in tall, debilitated, and phlegmatic people. *Age* materially influences the occurrence of the disease, which, rare in the earlier periods of life, gradually increases in frequency up to middle age when the tendency ceases. In *women*, especially, the affection is common ; in consequence, partly, of natural debility, but more frequently from the pressure of the enlarged uterus during pregnancy.

Locality.—The veins of the skin and the mucous membranes are those that are most liable to varix. It is most commonly met with in the legs, and more particularly in the trunk of the internal saphena. Simple dilatation may be met with in any of the superficial veins, as of the chest, arms, head, neck, hypogastrium, or thorax, but true varix in these situations is rare. The veins of the anus and lower part of the rectum are especially liable to varix, as they are but loosely supported by the surrounding parts, and are subject to over-distension from any cause that obstructs the hepatic circulation, such as cirrhosis of the liver. The spermatic veins also often become enlarged, constituting varicocele.

True varix is infinitely more common in the lower than in the upper part of the body, owing evidently to the influence of gravity in causing tension in the more dependent vessels. Dilatation of the veins at any point above the pelvis arises in most cases from the pressure of a tumour of some kind upon the large venous trunks, the superficial veins being enlarged to take the place of the deeper vessels that are obstructed. This condition may end in true varix, but if the enlargement is sufficient to enable the vein to carry the required quantity of blood easily there will be none of those changes of the coats which constitute true varix and are the result of abnormal tension. The deep-seated veins that are principally affected are the internal jugulars, the vena azygos, and the veins of the prostate.

Morbid Anatomy.—Veins that are simply dilated (phlebectasis) differ from true varicose veins in being merely increased in size, without any alteration in structure. Their walls are thin and soft, and they collapse readily. A varicose vein is increased in diameter and elongated, forming curves and bending back on itself. Sometimes the enlargements at particular points appear multilocular, the vein forming a series of curves and dilatations lying closely packed together. The coats of the vein are opaque, and thickened often to such an extent that the divided vessel stands open like an artery. Occasionally calcareous plates are met with in the thickened walls. On opening the vein the valves are always found to be insufficient ; sometimes they have disappeared altogether, and in other cases they form small ridges or bands projecting from the wall. When the vein has been cut up it will be seen that in some of the pouch-like dilatations the wall has become greatly thinned. The inner coat of the vein appears smooth and but little altered, beyond being often marked by longitudinal striæ. When the vein is subcutaneous, the small branches entering the trunk from the skin are often dilated, and this condition may sometimes be traced here and there into the cutis, which is thinned over the dilated vessel. In the wall of the vein and in its sheath small dilated veins belonging to the vasa vasorum are very commonly observed.

Microscopic examination shows that the thickening of the vein is chiefly due to a development of dense fibroid tissue in the middle coat. The muscular fibre cells are somewhat increased in number, but are separated widely from each other by the fibroid tissue. The outer coat is also thickened, the inner shows but little change. In the thinned pouches, the middle coat is atrophied, and may have completely disappeared.

Appearances and Symptoms.—Varicose veins are tortuous, dilated, and sacculated ; they are serpentine in their course, and feel thick under the finger. When superficial, the disease is often limited to one of the larger venous trunks, the smaller branches not being implicated. This we commonly see in the internal saphena. The pouch-like dilatations may often approach very closely to the surface, the skin being thinned over them, and the blue tint of the vein being readily perceptible. When the patient is erect the vein becomes more prominent and tense. In other cases the small superficial veins are affected, appearing in the skin as a close network of a purplish-blue colour, causing much discoloration of the parts. Both sets of vessels may be implicated. In consequence of the incompetence of the valves an impulse can often be felt even below the knee when the patient is made to cough. Varix of the deep veins is less common, as the vessels are better supported by the surrounding parts. They give rise to no appearance which can be recognized during life. Varicose veins cause a sense of tension and weight, often with considerable smarting or pricking pain in the parts from which they return the blood. Sometimes they may cause numbness, difficulty of movement, or even some loss of power in the affected limb. These symptoms are aggravated by exertion, and in deep-seated varix, they are often very marked.

Progress and Effects.—Varicose veins never undergo spontaneous cure ; when once formed, the condition is permanent, unless the vessel become plugged by coagulum, when it may be obliterated. The current of blood is then diverted into other channels, and as a rule these in their turn become varicose. The main evil that results from varicose veins in the legs, is the change that is slowly induced in the nutrition of the skin and subcutaneous areolar tissue, by the retardation of the circulation, and the interference with the due return of blood. The parts from which the vein derives its blood are often slightly œdematous. After a time the subcutaneous fat becomes indurated, and the skin loses its elasticity, becoming rigid and often darkly pigmented in places. In consequence of the imperfect nutrition of the parts ulceration frequently takes place, especially below the middle of the leg. The ulcer has a great tendency to assume the chronic or callous form. Chronic eczema is a frequent consequence of the congestion of the skin caused by varicose veins. There is another accident that may occur as the result of varicose veins of the legs, viz., that the varix may give way, the vein may "burst" as is generally said. In these cases, the word "burst" is scarcely correct. The varix does not give way solely by pressure from within; but a process of ulceration goes on from without by which its coats become weakened, so that at last a pin-hole aperture forms, giving rise to profuse hæmorrhage. The bleeding is often so abundant as to induce faintness, and sometimes even death in a few minutes. It takes place in a different way from ordinary venous hæmorrhage, the blood coming chiefly from the cardiac and not the distal side, the incompetent valves not presenting the ordinary obstacle to the downward flow of blood. It is this that causes its extraordinary copiousness. In most cases this so-called "bursting" is not so sudden but that a Surgeon may foresee the probability of its occurrence, as it most commonly takes place either on the surface of an ulcer, or is preceded by induration, reddening, and thinning of the integuments covering the diseased vein. In some cases, however, the warnings may be very slight. A few years ago a man was brought into University College Hospital, who had died in a few minutes from hæmorrhage from a varicose vein. There was nothing to be seen on the body but a minute hole, surrounded by apparently healthy skin. Water injected into the vena cava readily flowed out through the aperture. On injecting the specimen and dissecting it, a large mass of tortuous veins was found (Fig. 427), but the hæmorrhage had come from a small cutaneous vein which joined the varicose trunk. It had been dilated to the size of a crow-quill, and the cutis covering it was thinned. Varicose veins are very prone to suffer from inflammation and thrombosis. The symptoms are those of phlebitis already described. The inflammation is usually localized. Suppuration occasionally takes place, but spreading phlebitis and embolism are rare complications. After an attack of phlebitis the vein is often obliterated, and the patient cured of his disease.

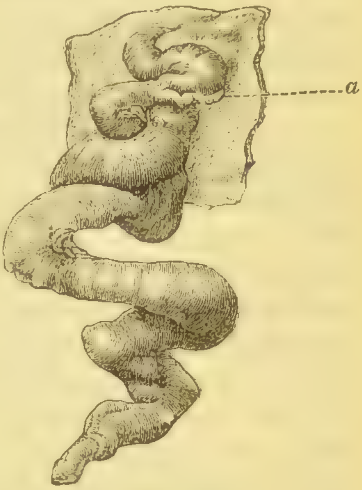

Fig. 427.—Varicose internal saphenous vein with a piece of skin attached. *a*. A small cutaneous vein dilated from which fatal hæmorrhage occurred.

Treatment.—This must be conducted on two principles—to palliate and to cure. The **Palliative Treatment** consists in moderate compression exercised upon the vessel, so as to support its weakened and dilated coats, and thus prevent its further distension and the pain occasioned by this, as well as the other consequences—such as œdema, induration and ulceration. The pressure must be applied very smoothly and evenly, lest it irritate the skin, and cause ulceration, or produce distension of the vein below the part compressed. For the purpose of compression, bandages and elastic stockings are commonly employed. The soft "stocking bandage" is one of the most comfortable. If an elastic stocking be used, care must be taken that it really fits evenly. They are often made too tight at the upper part. Martin's india-rubber bandage applied in the same way as in the treatment of the chronic ulcer (Vol. I., p. 269) is a most efficient and comfortable mode of treatment if the patient can wear it without its causing eczema. Elastic pressure by means of a vulcanized india-rubber band or gaiter applied around the limb, so as to simulate the action of the valves of the vein, and by its compression to cut off the weight of the column of blood from the terminal branches, has been recommended ; and Colles advised the application of a truss to the upper part of the saphena vein ; but as a rule these modes of treatment only aggravate the symptoms.

If a vein burst, the hæmorrhage is easily arrested by placing the patient on his back with the leg elevated and applying a compress and bandage. When a patient is in danger of hæmorrhage, he should be advised to have the vein at once obliterated ; and if this cannot be done, it should be explained to him that if bleeding comes on he has nothing to fear, if he lies on his back and elevates his leg against some convenient object nearly to a right angle with his body, till assistance can be obtained. The application of a finger to the bleeding spot would immediately arrest the hæmorrhage. When death takes place, it is while the patient is foolishly running about to seek assistance.

In certain circumstances, it becomes necessary to change the palliative for a **Curative** plan. This is especially requisite in the following three conditions : 1, if the varix be so large as to produce much inconvenience, or to give rise to severe pain by its pressure on the nerves in its neighbourhood ; 2, if a varicose vein have burst, or be on the point of giving way ; or, 3, if an ulcer dependent on its existence will not heal. Various plans of curative treatment have been recommended ; most of which have for their object the obliteration of the vein at one point by exciting inflammation there, and thus causing it to be filled by a thrombus which will extend as far as the next branch on each side. Finally, the vein becomes obliterated and reduced to a fibrous cord. As the treatment involves the artificial excitation of phlebitis and thrombosis, there is necessarily some little risk of its assuming a spreading form with softening of the clot and subsequent pyæmia. This however could occur only if septic inflammation were set up round the vein as a consequence of the wound made in the operation, or if the patient at the time of the operation was suffering from some serious general disease. By a little caution, therefore, such accidents can almost certainly be prevented.

By these means the trunk of a varicose vein and the larger masses of varix may be occluded. But can the disease be cured by the local obliteration of the vein ? To this question, I have no hesitation in answering in the negative. Though the trunk be obliterated, a collateral venous circulation is set up, which is very apt in the course of a few months to take on a varicose condition, and thus to cause a return of the disease. But, though the cure be not radical, much benefit may often be effected by removing varicose knots that occasion pain or inconvenience, by enabling an ulcer to cicatrize, or by occluding a vein from which hæmorrhage has occurred or is threatening to occur. Various plans for obliterating the veins have been recommended. They resolve themselves into five principal heads of treatment.

1. *Division of the Vein* has been done by a subcutaneous incision followed

by the application of a compress and bandage, but this plan is not to be recommended as it is uncertain and may be followed by considerable extravasation of blood beneath the skin.

2. *Excision of a portion of the vein* between two ligatures is the most certain mode of treatment, and can be safely undertaken if any efficient mode of antiseptic treatment be adopted in the treatment of the wound. Without this it is not unattended by danger from septic changes in the thrombus followed by pyæmia. Before the operation the limb must be thoroughly washed with soap and hot water, and afterwards wrapped for about ten minutes in a towel soaked in carbolic lotion (1 in 20), or sponged with a solution of perchloride of mercury (1 in 500). The veins must then be made prominent by the application of a bandage on the proximal side. The varicose vessel is then exposed by a small longitudinal incision about one inch in length, and two ligatures of prepared catgut are passed beneath it by means of an aneurism needle. After tying them, the portion of the vein between them may be cut out with scissors. The operation is repeated in as many places as may seem to be necessary to ensure the complete occlusion of the diseased vein. The edges of each wound may be brought together by a single stitch, after which an absorbent antiseptic wool dressing may be applied and left untouched for a week, at the end of which time the small wounds will usually be healed. This operation seems as free from danger and is less painful and more certain in its results than any other method of obliterating varicose veins.

3. *Coagulation of the blood in the vein by electrolysis* has also been recommended. A hare-lip pin is passed under the vein, and a twisted suture applied over it. Two insulated needles are then passed into the dilated vein below the pin, and a galvanic current of sufficient strength passed through them. The vein soon becomes filled with clot, and hard. After a few hours, when the danger of embolism is past, the pin may be removed. This plan has been tried at University College Hospital, but seemed to present no special advantages.

4. *Injection of the varix by a few drops of a solution of the perchloride of iron,* as recommended by Pravaz, is an effectual method of procuring coagulation of the contained blood and consolidation of the varix, more particularly if it be very large and sacculated. In employing this means, it is essential to compress the vein by means of a tourniquet applied above the varix, which must not be removed till half an hour at least after the operation, for fear of embolism. The solution is to be injected in very small quantity—not more than three or four drops—by means of the syringe (Fig. 429) into the dilated veins. Coagulation of the blood immediately takes place. The patient must be confined to his bed for a few days with the limb raised, and a bandage should be applied before he is allowed to walk about. This mode of treatment has been conjoined with the next method—the pins being used under the venous trunks, and the solution introduced into the dilated masses of the varix. But it is not devoid of danger; accidents, such as local suppuration and sloughing, pyæmic symptoms, and even fatal embolism, have followed its use.

5. A convenient and safe way of obliterating the vein, and one which was formerly almost universally employed, consists in *compressing the vessel at several points,* by passing a hare-lip pin underneath it, laying a piece of wax-bougie over it, and then applying the twisted suture around the pin and over the

bougie (Fig. 428). In this way the vessel gradually ulcerates by the pressure that is exercised upon it, and the presence of the bougie prevents the ligature from injuring the skin. In performing this operation, care must be taken that the vein be not transfixed, but that the pin be pushed, or rather dipped underneath it; the ligature should not be too thin, and must be applied tightly over the bougie; several pins, as many as eight or ten, if necessary, should be introduced along the course of the same vessel, at distances of about three-quarters of an inch from one another (Fig. 428); those highest up should be put in first, and they should be left in for at least a week or ten days, by which time the obliteration of the vessel will have taken place. I believe that all the danger of the operation consists in the possible transfixion of the vein by the pin; the operator may always know when he has done this by the escape of a few drops of venous blood; when the pin is properly passed under and clear of the vein, the operation is a perfectly bloodless one. If the vein be transfixed, the pin should immediately be withdrawn and passed at another point; if it be allowed to remain in the vein, it will act as a foreign body, and septic changes in the thrombus may ensue. When the vein is properly compressed between the pin below and the bougie above, it becomes safely obliterated at the point of pressure. By attention to these points I have never met with any ill consequences, either from phlebitis or pyæmia, in any of the cases in which I have performed this operation, which are several hundreds in number.

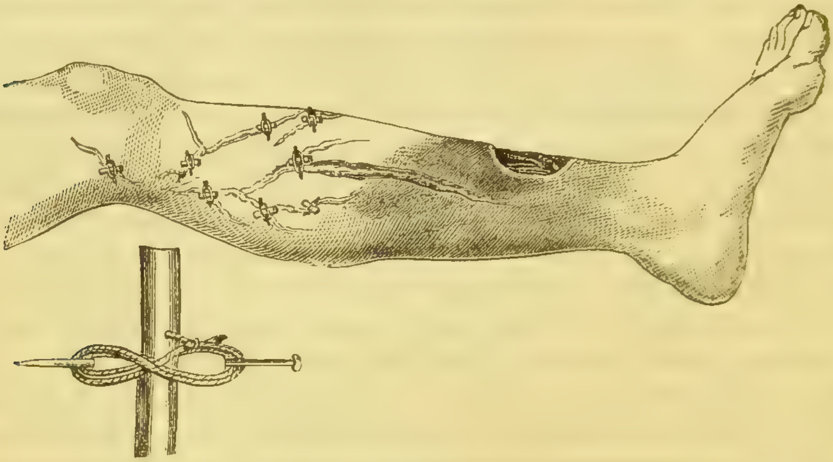

Fig. 428.—Application of Hare-lip Pins to Varicose Veins.

In addition to the application of the pins in the usual way, H. Lee has recommended the subcutaneous division of that portion of the vein which is included between them, after coagulation of the blood has taken place. This I have found to be a useful addition to the ordinary treatment, and to insure the obliteration of the vessel.

The points of the pins may be prevented from pressing injuriously upon the skin, by putting small pieces of adhesive plaster under them. Whilst the pins are in, the patient must not be allowed to move about, and after they have been taken out, the limb should be bandaged for some time. In general, no ulceration takes place about the pin-hole apertures; but occasionally, in debilitated constitutions, a sore forms, which requires to be treated on ordinary principles.

CHAPTER XLI.

ANEURISM BY ANASTOMOSIS, AND NÆVUS.—HÆMORRHAGIC DIATHESIS.

ANEURISM BY ANASTOMOSIS.

Aneruism by Anastomosis, or Cirsoid Aneurism, is a rare disease of the arteries, in which they become excessively elongated, tortuous, and serpentine ; sometimes they assume a varicose condition, being dilated into small sinuses, and are always very thin-walled, resembling rather veins than arteries in structure. This kind of dilatation of the vessels gives rise to pulsating tumours, often of considerable size, and of a very active and dangerous character. They may be situated in almost any tissue or organ of the body, but are generally met with in the submucous and subcutaneous areolar tissue, and most frequently in the upper part of the body, especially about the scalp, orbit, lips, and face ; but they have been seen in other situations, such as the tongue, and even in internal organs, as the liver ; and I have had under my care very active tumours of this kind on the side of the chest, nates, and foot. It will generally be found that the arteries leading to an aneurism by anastomosis, though at a considerable distance from it, are tortuous and enlarged, with thin and expanded coats, and pulsate actively ; in fact, constituting that condition that goes by the name of **Cirsoid Dilatation** of the vessels.

Aneurisms by anastomosis form tumours of varying magnitude and irregular shape ; they are usually of a bluish colour, have a spongy feel, are readily compressible, not circumscribed, and have large tortuous vessels running into and from them on different sides. Their temperature is generally above that of neighbouring parts ; and a vibratory or purring thrill, with distinct pulsation, may be felt in them. This is synchronous with the heart's beat, may be more or less completely arrested by compressing the tumour or the arteries leading to it, and returns with an expansive beat on the removal of the pressure. The bruit is often loud and harsh, but at other times of a soft and blowing character. These tumours rarely occur in infancy, but generally make their appearance in young adults, though they may be met with at all periods of life, often as the consequence of injury.

Diagnosis.—It is of importance to make the diagnosis between *ordinary aneurism* and that by anastomosis. In many cases the situation of the tumour at a distance from any large trunk, as on the scalp, the outside of the thigh, or the gluteal region, will determine this. Again, the outline of the tumour is less distinct than in true aneurism ; and tortuous vessels will be felt leading to it from different directions. The swelling also is doughy and very compressible ; but, when the pressure is removed, the blood enters it with a whiz and thrill, not with the distinct pulsating stroke that is found in aneurism.

The pulsation, not so forcible as in aneurism, is more heaving and expansile. The bruit is louder, and more superficial, sometimes having a cooing tone. By pressure on the arteries leading to the tumour these signs are usually not entirely arrested, though diminished in force, the blood entering it from the neighbouring parts, and in a less direct way.

Treatment.—The treatment of aneurism by anastomosis must depend upon the size and situation of the growth. When it is so placed that it can be *ligatured* or *excised,* as on the lip, or when small, about the neck, face, or scalp, trunk, or extremities, it should be removed. I always prefer the ligature, applied as will immediately be described, as being the safest, and upon the whole the readiest mode of removing such a tumour. If excision be practised, it is necessary to be very careful to cut wide of the disease ; if it be cut into, fearful hæmorrhage may ensue, which can only be arrested by pressure, and which in several instances has proved fatal.

If the disease be very large and extended, as is commonly seen on the scalp, or if deeply seated, as in the orbit, neither ligature nor excision of the tumour can be practised, and it becomes necessary to starve it by cutting off its supply of blood. This may be done either by *ligaturing the principal branches leading to it,* or *the main trunk* of the limb or part.

Simple ligature of the *arterial branches leading to the tumour* has never, I believe, been followed by success ; at least, in ten recorded instances in which it has been had recourse to, the disease has not in one instance been cured. It has, however, been successfully conjoined by Gibson, in two cases of aneurims by anastomosis of the scalp, with incisions made round the tumour at intervals between the principal feeding arteries, which at the same time were tied.

The *main trunk leading to the tumour* has been ligatured in a considerable number of cases. The brachial and femoral arteries have been tied for disease of this kind situated on the extremities, and in some instances with success ; but the carotid is the vessel that has been most frequently deligated, in consequence of the tumour being commonly situated on the scalp and in the orbit. Wyeth has collected 98 cases in which the carotid was ligatured for vascular growths above the clavicle, and .excluding cases of " intra-orbital aneurism." The results have not been encouraging ; in 73 cases in which the common carotid was tied, nearly 30 per cent. died directly from the operation, and about half only of those that recovered derived any benefit from it. Both common carotid arteries were tied at varying intervals in 9 cases ; of these 2 died, 1 was cured, 2 improved, and the rest recovered, but derived no benefit from the operation.

In many of the cases in which one carotid alone was tied, the disease, being seated upon the scalp, was not cured : and it was afterwards found necessary to have recourse to ligature of the tumour, to excision, and to other means of removal ; indeed, when seated upon the scalp, this disease appears to be more intractable than in any other part of the body, owing probably to the freedom of the arterial supply from the numerous vessels that ramify in this region. Here, however, much benefit might be derived after ligature of the carotid, by adopting the plan suggested by Gibson of tying the feeding arteries, and making incisions between them down to the bone. The ligature of the carotid has answered better for pulsating tumours in the orbit, but few of these are true cirsoid aneurisms. (See Intra-Orbital Aneurisms.)

NÆVUS.

This disease, under which are included those various affections termed **Mother's Marks, Erectile Tumours,** and **Vascular Growths,** constitutes an important and interesting section of surgical affections.

Nævi are commonly divided into two chief varieties, capillary or cutaneous, and venous, cavernous or subcutaneous. Aneurism by anastomosis was formerly included under the name of arterial nævus. The simple capillary nævi are composed merely of the capillary vessels of the skin greatly increased in size and number : the cause of their growth is quite unknown. Venous or cavernous nævi are usually definitely circumscribed tumours, composed of spaces lined with an endothelium similar to that of the veins and bounded by a thin wall. The whole mass is bound together by a delicate areolar tissue. The spaces are filled with dark venous blood. The arterial supply is usually small, and the arteries open directly into the spaces, without the intervention of capillaries. These nævi are sometimes purely subcutaneous, but more commonly implicate the skin. The most common condition is to find the two forms of nævus conjoined, the disease assuming the capillary form in the skin and the venous beneath. In some cases the subcutaneous nævus is not clearly defined, but consists of a mass of tortuous, thin-walled veins, surrounded by a considerable quantity of areolar tissue, sometimes containing fat. In fact, the structure of the various nævoid growths differs considerably in different cases, and the various forms merge into each other. (See also Angiomata, Vol. I., p. 1022.)

According to R. W. Parker 67 per cent. of nævi occur in female children. They are almost always, if not invariably, congenital. Cavernous nævi occasionally seem to appear in young adult life, but it is probable that these were originally of congenital origin, and commenced active growth at an unusually late period.

Capillary Nævi appear as slightly elevated but flat spots on the skin, of a bright red or purplish tint, and having occasionally granular or papillated elevations, with some larger vessels ramifying on their surface. They often spread superficially to a considerable extent ; they are usually situated on the face, head, neck, or arms, but occasionally, though more rarely, on the back, the nates, the organs of generation, and the lower extremities. They are, often at birth very small, not larger than a pin's head, from which they may spread in the course of a few weeks or months to patches an inch or two in diameter. In many cases no inconvenience results from this disease, except the deformity it causes ; but occasionally, more especially when the growth is at all prominent, there is a great disposition to unhealthy ulceration. When bleeding occurs from a wound of the nævoid structure it is usually in a trickling stream, and without any degree of force.

Venous or **Cavernous Nævi** are of a dark purple or reddish colour, usually very prominent, and often forming distinct tumours of considerable size, which may either be smooth and ovoid, or somewhat lobulated. On compressing a growth of this kind, it subsides to a certain extent, feeling doughy, soft, and inelastic ; on the removal of the pressure it fills again. In some cases, when consolidated by inflammation, or containing cysts, they cannot be lessened in bulk by pressure. These nævi are usually of about the size of halt a walnut, but sometimes much larger. I have removed from the nates and the back some quite as large as an orange. They occur less frequently upon the head and face than the capillary form of the disease; most of the instances that I have seen have been in the lower part of the body, about the nates, back, lower extremities, and organs of generation.

When a venous nævus is purely subcutaneous, it forms a soft, doughy tumour, often clearly defined in outline. Its most characteristic feature is that it can be diminished by pressure, on the removal of which it slowly fills out again to as large a size as before; it also becomes distended when the child screams or struggles. It is usually oval, smooth, and uniform in outline. Occasionally the surrounding veins are bluish and enlarged.

Cysts are sometimes found in nævi containing a dark fluid. They result from obliteration of the communication between some of the spaces of the nævus and the vessels which carry off the blood. The tumours once supposed to be consolidated nævi, with cysts scattered through them containing clear fluid, are now regarded as of lymphatic origin.

Prognosis.—The natural history of nævi is somewhat uncertain. They are so commonly removed by operation, that we have yet to ascertain what becomes of them when left to themselves. I have, however, seen several cases in which from various circumstances no operation had been performed, and I have been struck with the tendency that there is in the cutaneous nævus to disappear. If left untouched, or subjected to continuous pressure, islands or patches of white skin will gradually appear on the reddened surface. These will slowly increase and coalesce, and then the nævus, becoming gradually less vascular, may in time disappear. Subcutaneous venous nævi will sometimes gradually shrink, but the active erectile nævus is always progressive.

There is usually a fear expressed of nævi, if left without surgical interference, leading to dangerous or even fatal hæmorrhage. This I have never seen; indeed, if the nævus ulcerates its tissue hardens, and the vessels become blocked up by coagulum and hence less disposed to bleed.

Treatment.—In the treatment of nævus, the first point to be determined is whether the case should be left to nature, or whether operative measures should be had recourse to. In deciding this we must be guided by the size, situation, and character of the morbid growth. If it be small, cutaneous, and superficial, so situated that it occasions little or no disfigurement, and if it show no tendency to increase, it may be left without interference; when, as just stated, it may eventually shrivel and disappear, or become converted into a kind of mole. In some cases this process may be hastened by the application of tincture of iodine or liquor plumbi. In other cases, again, the nævus, though cutaneous and superficial, is so widely diffused over the surface, that no attempt at its removal or destruction can be entertained with prudence. But, if the nævus be large, if it be subcutaneous, if it increase in size, or if it be so situated as to occasion disfigurement, means must be adopted for its removal by operative procedure.

Operations for the removal of nævi may be conducted on six principles:—1, to excite inflammation in them, and so to produce plugging and obliteration of the vascular tissue of which they are composed; 2, to destroy the growth by caustics; 3, to remove it by the cautery; 4, to consolidate it by electrolysis; 5, to remove it with the knife; or, 6, to remove it by ligature. Each of these different plans of treatment is peculiarly applicable when the disease assumes certain forms, and affects certain situations.

1. When the nævus is of small size, and occurs in such situations that its destruction by caustics, or its removal by knife or ligature, would be attended by serious deformity, as when it is seated about the eyelids, upon the tip of the nose, at the inner angle between the eye and the nose, or about the corners of the mouth, it is best *to endeavour to procure obliteration, by exciting inflammation in it.* This may be done in various ways. If small, the nævus may be vaccinated. If it be larger, the most convenient plan consists, perhaps, in passing a number of fine silk threads across the tumour in different directions, and leaving them in for a week or two at a time, until they have produced sufficient inflammation along their tracks, then withdrawing them and passing similar threads into other parts of the tumour. In this way its consolidation may gradually be effected. Another very useful plan is to break up the substance of the growth subcutaneously by means of a cataract-needle, or tenotome, and, in the intervals between the different introductions of this instrument, to keep up pressure upon the tumour. Perhaps the most efficient way of attaining this object is by injecting the perchloride of iron by means of a small glass syringe with a screw-piston rod and a fine sharp-pointed platinum nozzle (Fig. 429). In doing this, care must be taken that but a very small quantity of the solution, not more than two or three drops, be injected at one time. The perchloride of iron possesses extraordinary power of coagulating the blood ; and, if more than has just been mentioned be thrown in, the tissue of the nævus may either have its vitality destroyed, and slough, or coagulation of the blood in the vessels beyond the nævus may occur, and a dangerous or even fatal embolism ensue from the coagulum thus formed being washed into the current of the circulation. In order to prevent this latter accident a tourniquet should be placed on a limb if it be the seat of the nævus. If the nævus is seated on any other part, two hare-lip pins must be passed beneath it, and a temporary ligature applied beneath the pins during the operation ; this can safely be removed after about a quarter of an hour. If preferred, tannic acid dissolved in water in the proportion of ʒj to ℥j, as recommended by Bryant, or a few drops of a strong solution of chloride of zinc, or pure carbolic acid, may be injected instead of the perchloride of iron.

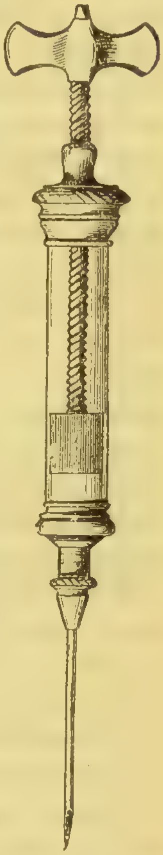

Fig. 429.—Syringe for Injecting Nævus.

2. When the nævus is small, very superficial, of the capillary character, with an exceedingly thin covering of cuticle, and so situated, as upon the arm, neck, or back, that a moderate amount of scarring is of little consequence, it may most conveniently be removed by the *free application of nitric acid.* This should be well rubbed on by means of a piece of stick. The skin round the nævus may be greased to prevent its being accidentally touched by the acid ; and as soon as the caustic has been sufficiently rubbed in, it must be neutralized with some carbonate of soda. After the separation of the slough, the application must be repeated as often as there is any appearance of prominent granulations springing up, which occasionally happens at one angle of the wound, and indicates a recurrence of the vascular growth.

3. The *actual cautery* has been largely used in the treatment of nævi, and is

extremely convenient and efficacious in many cases. It is most applicable to mixed cutaneous and subcutaneous nævi. It may be used as the galvanic cautery or as Paquelin's thermo-cautery. The heated platinum wire or the pointed cautery in Paquelin's apparatus is made to puncture the growth round its margin, leaving about a quarter of an inch between the separate punctures. Each should extend well into the subcutaneous portion of the tumour. A number of other punctures are then made into the tumour in the central part, care being taken not to make too many, lest the whole mass slough. In this way a large nævus can often be destroyed with comparatively little loss of skin, a smooth white scar being left. It is often necessary to repeat the operation more than once before a cure is effected. After the operation boracic acid ointment or some other simple dressing must be applied.

4. *Electrolysis*, or *galvano-puncture*, is best adapted to those cases of deep-seated nævi in which other treatment is difficult, or to those so situated as to make it important, if possible, to save the skin. The operation is performed by passing into the nævus two needles, insulated except for the last quarter of an inch by a coating of copal varnish, and then connecting them with a galvanic current of moderate strength from one of the ordinary medical batteries. The current should be gradually increased and the effect watched. The tumour becomes hard somewhat suddenly, and assumes a pale or almost white tint; this is a sign that enough has been done. The moment the earliest sign of hardening appears the needles should be disconnected, and connected with the opposite poles of the battery, so that the needle which was negative becomes positive. By doing this hæmorrhage is prevented when the needles are withdrawn, as the salts of iron formed by solution of the positive needle serve as an efficient hæmostatic. If gas bubbles out alongside the needles it is a sign that the current is too strong, and some cells should be taken off, or sloughing may result. In deep-seated nævi the effect can be judged of only by the hardening of the tumour. The operation has often to be repeated several times before the nævus is finally cured.

5. *Excision* is applicable both to capillary and venous nævi when the growth is so situated as to render the operation practicable. Small cutaneous nævi of the face or scalp may easily be removed in this way by making an elliptical incision including the growth, and bringing the wound together accurately with horse-hair stitches. In this way a scarcely perceptible linear scar will be left. In larger deep-seated cavernous nævi, which are frequently distinctly encapsuled, Pridgin Teale has shown that excision may be easily performed with but little risk of hæmorrhage as the feeding vessels are few and small. Should the nævus, however, be diffused without any distinct limiting capsule, care should be taken to cut wide of the disease; and in such cases, as a rule, it is safer not to attempt the operation unless the growth is so situated that hæmorrhage may, if necessary, be readily controlled by pressure after the operation. It is especially when the nævus is indolent and purely cavernous, or when it is lipomatous or cystic, and distinctly encapsuled, that excision may be advantageously practised.

6. The most generally adopted and convenient method of extirpating the growth is by the *ligature*. This mode is generally applicable to nævi in almost all situations, as it effectually removes them without risk of hæmorrhage, and leaves a sore that very readily cicatrizes.

The ligature requires to be applied in different ways, according to the size and situation of the tumour. In all cases, the best material is firm, round, compressed whip-cord, which has been previously rendered aseptic by carbolic acid or perchloride of mercury. This should be tied as tightly as possible, and knotted securely, so that there may be no chance of any part of the tumour escaping complete and immediate strangulation. It is well, if possible, not to include in the noose any healthy skin, but to snip across with a pair of scissors that portion of integument which intervenes between the cords that are tied together ; at the same time, care must be taken to pass the ligatures well beyond the limits of the disease. After the growth has been strangulated it may be punctured to let out the blood, and then injected with a few drops of chloride of zinc (1 in 40) or carbolic acid. Its surface may then be dusted with iodoform, and covered with iodoform wool, sealed down with collodion. The mass thus forms a dry aseptic scab, which separates in a few days, with scarcely any suppuration, leaving a healthy sore beneath.

When the tumour is small, an ordinary double ligature may be passed across its base, by means of a common suture-needle ; and, the noose being cut and the thread tied on each side, strangulation will be effected. When it is of larger size, and of round shape, the most convenient plan of strangulating the tumour is that recommended by Liston. It consists in passing, by means of long nævus-needles, fixed in wooden handles, and having their eyes near their points, double whip-cord ligatures in opposite directions across the tumour ; then cutting through the nooses, and tying together the contiguous ends of the ligatures until the whole of the growth is encircled and strangled by them. In doing this, a few precautions are necessary : thus, the first nævus-needle should be passed across the tumour unarmed (Fig. 430), and used to raise up the growth somewhat from the subjacent parts. The second needle, armed as represented in the diagram (Fig. 430), carrying the whip-cord ligature by means of a piece of suture silk, should be passed across the tumour in the

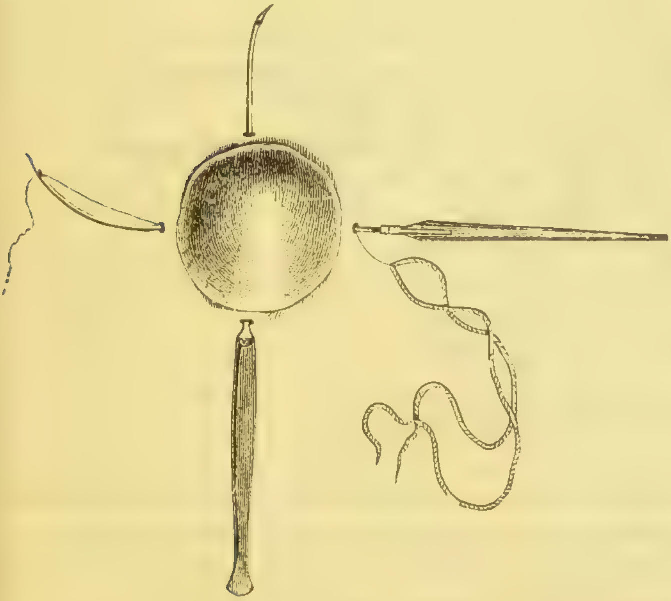

Fig. 430.—Diagram of the Application of Nævus-needles.

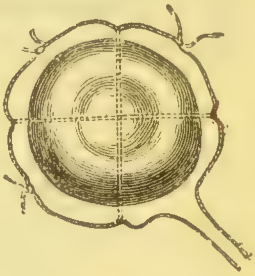

Fig. 431.—Diagram of Nævus tied.

opposite direction to, but underneath, the first needle ; the armed needle being withdrawn, the ligature is carried across ; and the first one, having been armed in the same way, carries its noose through the tumour as it is drawn out. The two nooses having then been cut, an assistant must seize, but not draw upon, six of the ligature ends ; the Surgeon then, having divided the intervening bridge of skin, ties rather tightly, in a reef-knot, the two ends that are left hanging out ; as soon as he has done this, he proceeds to the next two, and so on to the last (Fig. 431). When he ties these, he must do so with all his force, especially if the tumour be large, as by drawing on them he tightens all the other nooses, and drags the knots towards the centre of the growth, which is thus effectually strangled. He then cuts off the tails of the ligature. After the tumour has sloughed away, which happens in a few days, if it be properly and tightly strangled, the wound is treated on ordinary principles. If the nævus be altogether subcutaneous, the skin covering it should not be sacrificed, but, being divided by a crucial incision, may be turned down in four flaps, and the ligature then tied as directed.

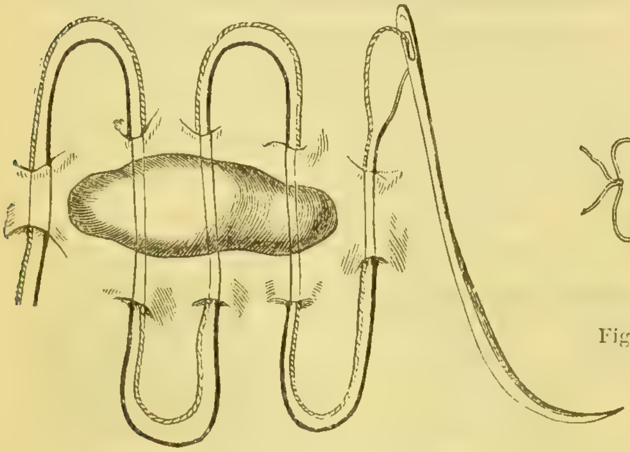

Fig. 432.—Diagram of Ligature of Flat and Elongated Nævus.

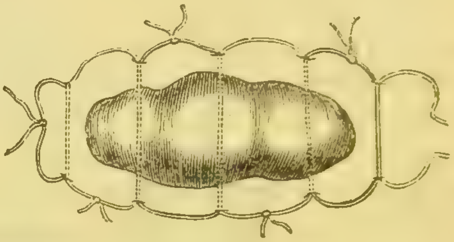

Fig. 433.—Diagram of Flat and Elongated Nævus tied.

In some cases, the nævus is so flat and elongated that the application of the quadruple ligature, as above described, cannot include the whole of it. In these circumstances, I have found the ligature about to be described eminently useful, having successfully employed it in a great number of instances. Its great advantage is that, while it completely and very readily strangles the tumour, it does not enclose an undue quantity of integument, and thus does not produce a larger cicatrix than is necessary for the eradication of the growth. It is applied in the following way. A long triangular needle is threaded on the middle of a piece of whip-cord about three yards in length ; one half of this is stained black with ink, the other half is left uncoloured. The needle is inserted through a fold of the sound skin, about a quarter of an inch from one end of the tumour, and transversely to its axis. It is then carried through, until a double tail, at least six inches in length, is left hanging from the point at which it entered ; it is next carried across the base of the tumour, entering and passing out beyond its lateral limits, so as to leave a series of double loops about nine inches in length on each side (Fig. 432). Every one of these loops should be made about three-quarters of an inch apart, including that space of the tumour; and the last loop should be brought out through a fold of healthy integument beyond the tumour. In this way we have a series of double loops, one *white*, and the other *black*, on each side (Fig. 432). All the *white* loops should now be cut on one side, and the *black* loops on the other, leaving hanging ends of thread of corresponding colours. The tumour may now be strangulated by drawing down and knotting firmly each pair of *white* threads on one side, and each pair of *black* ones on the other. In this way the tumour is divided into segments, each of which is strangulated by a noose and a knot; by *black* nooses and *white* knots on one side, by *white* nooses and *black* knots on the other (Fig. 433).

The cicatrix resulting from the removal of a nævus is usually firm and healthy; but, in some instances, I have seen it degenerate into a hard warty mass requiring subsequent excision. The ligature may be used successfully at all ages. I have repeatedly tied large active nævi in infants a month or two old without meeting with any accident.

In some situations in which it is very desirable to save the skin, the nævus may sometimes be cured by *subcutaneous ligature.* This is done by passing a curved nævus needle armed with a strong silk ligature as far as possible round the growth, immediately beneath the skin; on the eye emerging the thread is secured and the needle withdrawn. The needle is then passed unarmed so as to include the other half of the tumour; as soon as its eye appears it is threaded with the end of the ligature and drawn back. The ligature is then tightened, and the nævus thus strangulated subcutaneously. If preferred, the operation can be done with a common suture needle, which can be withdrawn and re-inserted where necessary without being re-threaded. The silk ligature separates by suppuration after a week or ten days.

Attempts have been made to apply subcutaneous ligatures of carbolized silk or catgut, and then to push the knot in at the needle-puncture, leaving the thread to be absorbed. This method has not, however, been very successful, as either the ligature excited suppuration and was finally expelled, or after its absorption a return of the growth took place.

Widely diffused capillary nævi admit of but little treatment. Various attempts have been made to diminish the disfigurement by the application of superficial caustics, but the results of this treatment are not satisfactory.

Balmanno Squire has recommended scarification of the surface with an instrument composed of a number of very fine knife blades set closely together, and from this some benefit has resulted.

NÆVI IN SPECIAL SITUATIONS.—**Nævi of the Scalp** are more frequent than in any other situation, except, perhaps, the face. When occurring on those parts that are covered by hair, they are almost invariably prominent and subcutaneous: when seated on the forehead, or on the bare skin behind the ears, they are often cutaneous. The ordinary subcutaneous nævus of the scalp is readily removed by the application of the *quadruple ligature.* Care must be taken in passing the needles not to include the tendon of the occipito-frontalis, or troublesome cellulitis and perhaps suppuration may occur beneath that membrane. In general, it is better not to attempt the preservation of any of the integument covering the growth. It is true that, when removed, a clean white cicatrix is left which never covers itself with hair; but this contracts, and in after-life becomes but little visible. The attempt to dissect down the skin that covers the nævus is not only troublesome, but is attended by very considerable, and possibly dangerous, hæmorrhage. Those flat nævi that are situated behind the ear are best treated by the free application of fuming nitric acid, or Paquelin's cautery.

Nævus of the Fontanelle is the most important variety of the scalp-nævus, and constitutes a somewhat formidable disease. A large purple tumour is situated over the anterior fontanelle, rising and falling with the pulsations of the brain communicated to it, and becoming distended and tense when the child cries. The tumour is evidently close upon the membranes of the brain, and this often deters practitioners from interfering with it; and I have not unfrequently seen cases in which the parents of the child have been counselled not to allow any operation to be practised, lest death should result. Yet this tumour, so formidable in appearance, may be removed with perfect safety by the *ligature*. I have often tied nævi in this situation, and have never seen any ill consequences, not even a convulsive fit, occur. The danger, then, from the mere strangulation of the tumour in this situation cannot be great; but there is another and a special danger, viz., the risk of wounding the membranes of the brain in passing the ligatures under the base of the tumour. If nævus needles or sharp-pointed instruments of any kind be used, this accident will be very likely to occur; and, if this were to happen, inevitably fatal consequences would ensue. This accident may always be avoided by operating in the following way. A puncture is made in front of the tumour through the healthy scalp. An eyed probe, armed with a double ligature, is then pushed through this opening across the base of the tumour, and its end is made to project on the opposite side beyond it: here another puncture is made, and the probe and ligature together are drawn through. The same procedure is adopted across the tumour sideways. In this way, a quadruple ligature is passed across the tumour in two opposite directions: the ends are then disengaged, and the ligature is tightened in the ordinary way.

Nævi of the Face are of very common occurrence, and usually cause much disfigurement. The treatment to be adopted necessarily varies greatly, according to the nature of the nævus, whether cutaneous, subcutaneous, or both; and especially according to its situation. We shall, accordingly, consider the treatment of these vascular growths, as they affect the eyelids, the nose, the cheeks, and the lips.

Nævus of the Eyelids is usually cutaneous, consisting of a discoloration or staining, as it were, of the lid, without any material swelling. Such a disease is, I think, better left untouched; it cannot, of course, be removed either by the knife or by caustics, without producing worse results: and, as the skin is always deeply involved, milder means are inoperative, or possibly equally destructive. I have heard of sloughing of the eyelid being occasioned by the use of astringent injections: though, if the nævus were subcutaneous and constituted a distinct tumour, passing perhaps into the orbit, destruction of the growth by electrolysis is the safest and most efficient mode of treatment.

Nævus of the Nose may occur in two situations—at the root, or towards the alæ and apex. When seated at the root of the nose, upon the bridge, or at the lower part of the forehead, between and perhaps extending above the eyebrows, it is often subcutaneous, and may attain a very considerable magnitude. In cases of this kind, I have found the *quadruple ligature* the readiest means of removal; and although the part included may be of large size, the resulting cicatrix is wonderfully small and narrow, usually becoming horizontal, so as to fall into the folds of skin naturally existing in that situation. In the case of a little girl about three years of age, under my care some few years ago, I removed a nævus that was cutaneous as well as subcutaneous, and as large as a walnut, from this situation, by means of the quadruple ligature, with the most satisfactory result, the resulting cicatrix being remarkably small; and in another little girl, from the bridge of whose nose I removed, some years ago, a nævus as large as a marble, very little scarring or deformity resulted. If the skin be not affected, the application of a temporary ligature followed by injection of tannic acid, or pure carbolic acid, may be advantageously employed, or the growth may be destroyed by electrolysis. When the tip and alæ of the nose are affected, the nævus being cutaneous, we can seldom do much to improve the appearance of the patient. In such cases, I have tried breaking down the nævus, and the galvanic cautery, without any material benefit; the destruction of the tissues soon afterwards leading to deformity. When the nævus is subcutaneous, occupying the tip, alæ, and columna nasi, galvano-puncture, or injection with perchloride of iron, are the only means that I have found of real service. If the perchloride be injected, care must be taken not to throw in too much of the liquid, lest sloughing or sudden death result.

Nævi of the Cheeks may occur in three distinct forms. 1. There may be a simple cutaneous nævus, a mere staining of the skin, a "mother's mark." This admits of no satisfactory treatment in most cases; and the subject of it must submit to exhibit the characteristic discoloration through life. 2. The elevated cutaneous nævus may be raised above the surface, being of a deep purplish red or plum colour, and covered with a very thin integument. In this form of the disease, I think that the application of concentrated nitric acid is the best means of extirpation. By one or two free applications of the caustic, the growth is removed, and a dense white cicatrix, presenting little disfigurement, is left in its place. 3. The nævus may involve the whole thickness of the cheek, being scarcely, if at all, cutaneous. Nævi of this kind cannot, of course, be extirpated, either by the knife, ligature, or caustics, lest the cheek be perforated, and the most serious disfigurement ensue. In such cases we must endeavour to obliterate the structure of the nævus by galvano-puncture, by exciting inflammation in it by setons, or by breaking down the structure of the growth with cataract-needles or a fine tenotome. In a case which I attended some years ago, I cured a large and deeply seated nævus, which occupied one cheek, by passing a number of fine silk threads across it in different directions, and gradually breaking it down piece by piece, with a cataract-needle; no disfigurement whatever was left.

Nævi of the Lips require different treatment, according as they occupy the margin or have involved the whole substance of these parts. When seated at the margin, as projecting and somewhat pendulous growths, they may very readily be removed by a double or quadruple ligature, according to their size. This was the practice pursued in the case from which the accompanying drawings (Figs. 434, 435) were taken, where a most excellent result was obtained by the use of the ligature, followed at a later period by injection of perchloride of iron into some of the more widely diffused parts of the growth. When the nævus involves the whole thickness of the lip, such measures are not always available. In these cases galvano-puncture, repeated at intervals of about a week till the whole growth is consolidated, is perhaps the safest and best treatment. The injection of perchloride of iron, tannic acid solution, or chloride of zinc, may effect a cure in most cases; but a temporary ligature should always be applied, and left on for about a quarter of an hour, to prevent any accident arising from the direct entrance of the styptic fluid into the blood stream.

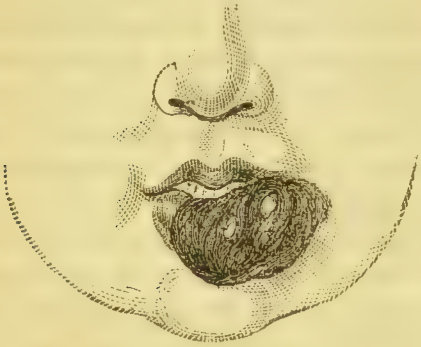

Fig. 434.—Nævus of Lower Lip: Front View.

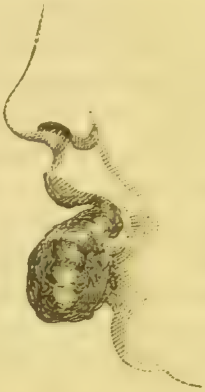

Fig. 435.—Nævus of Lower Lip: Side View.

When the whole substance of the lip is involved, strangulation by means of the ligature is seldom available, as the amount of sloughing being very great, the child would incur the danger of septic poisoning. In an infant with a very large nævus, including one half of the lip, which I ligatured at the Hospital many years ago, death appeared to result from this cause. One of the most formidable cases of nævus of the lip that I have ever had to do with, and in its results the most satisfactory, was sent to me several years ago, by Budd of Barnstaple. The patient, a little girl five years old, was noticed at birth to have a red streak on the right side of the upper lip; this rapidly developed into a large tumid purple nævus, which, when the case came under my observation, was about the size of

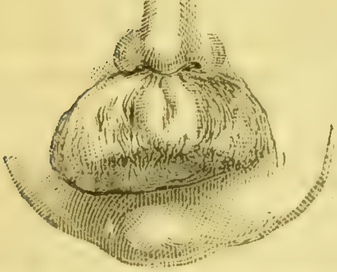

Fig. 436.—Large Nævus of Upper Lip: Front View.

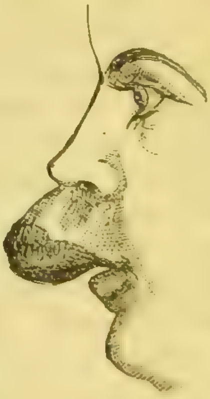

Fig. 437.—Large Nævus of Upper Lip: Side View.

a large walnut, involving the whole of the structures of the lip, from the cutaneous to the mucous surfaces; it was of a deep mulberry colour, and extended from the median line of the lip to the angle of the mouth (Figs. 436, 437). The integuments covering this growth were exceedingly thin, and the tumour itself was in the highest degree vascular and active. Excision appeared to be out of the qestiuon; the ligature presented little to recommend it; injections with the perchloride of iron and the introduction of setons were successively tried, but neither of these means produced any effect on the tumour, which commenced to extend upwards into the nostril. I accordingly determined on using caustics. Nitric acid was first employed; but, as this did not produce sufficiently deep impression on the growth, I had recourse to the potassa cum calce. By means of this, the tumour was gradually removed; the hæmorrhage which occasionally resulted being restrained by pressure. Notwithstanding the amount of tissue destroyed, the resulting cicatrix was small, resembling that of a badly united hare-lip. Three years afterwards, the child was brought to me again, and I was much struck by the wonderful improvement that had taken place since the removal of the nævus. The lip was smooth, the cicatrix in a great degree worn out, and comparatively little disfigurement was left in the countenance of an exceedingly pretty and engaging child. Finding, however, that the lip was still drawn or tucked in by a very dense band of cicatricial tissue, which caused a deep depression of the ala of the nose, on that side, I divided this, and the result was most satisfactory.

It has been recommended when the growth invades the substance of the lip deeply for a limited extent, to remove it by an operation somewhat similar to that for the removal of an epithelioma; the whole substance of the lip being cut through widely on each side, and the sides of the wound brought together with hare-lip pins. Such operations are, however, not advisable, as, apart from the danger of hæmorrhage, the disease can always be cured by some of the means above described, without leaving the amount of deformity that would result from its removal by the knife.

Nævus of the Tongue is of rare occurrence. I have, however, successfully operated by means of the écraseur in one case, in which the whole of the free extremity of the organ was involved (Fig. 438). The particulars will be found in Chapter LIX.

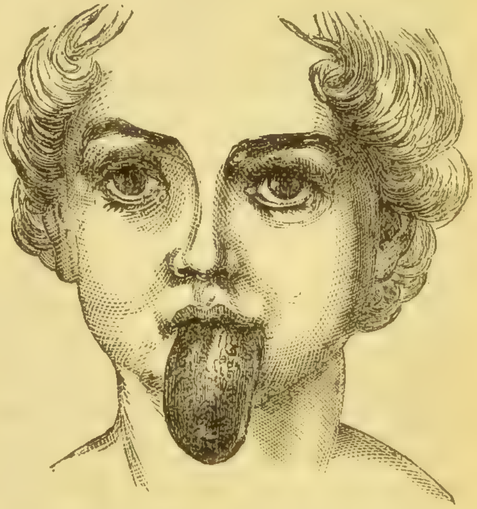

Fig. 438.—Nævus of Tongue.

Nævi of the Organs of Generation are occasionally met with in the female, but rarely in the male. The only instance of *Nævus of the Penis* with which I have met occurred in the case of a gentleman thirty-two years of age, who consulted me some years ago for a growth of this kind, as large as a walnut, situated under the reflexion of the preputial mucous membrane. It had existed for many years without giving any annoyance, but, as it had of late begun to enlarge, and occasionally to bleed, he was desirous of having it removed. This I did by applying the quadruple ligature, after having dissected the mucous membrane down.

Nævi of the Vulva are by no means unfrequent. They are usually venous, often attain a large size, and may sometimes involve the inside of the thigh, or the perinæum, as well as the vulva. When the growth is confined to the vulva, it is best removed by the ligature. Some time ago, I removed in this way a large pendulous venous nævus, as large as two or three flattened walnuts, from the left labium of a little girl six years of age. In this case, I found it most convenient to employ the continuous ligature. The same means were had recourse to in order to extirpate a large nævus from the labium of a child three years of age ; but in this case the disease extended to the integuments of the perinæum and inner side of the thigh, and was here removed by the application of strong nitric acid, after the larger growth had separated.

NÆVOID LIPOMA.—This is a form of nævus which I have occasionally seen, but which does not appear to have attracted much notice, although Nélaton speaks of it, and Billroth says that in lipoma he has several times met with cavernous dilatation of the veins. It is a tumour in which the nævoid structure is conjoined with a fatty growth usually more fibrous than an ordinary lipoma. This disease is invariably seated upon the nates, back, or thigh. It occurs as a smooth, doughy, indolent tumour, incompressible, not varying in size or shape, without heat, thrill, or pulsation of any kind, possibly having a few veins ramifying over its surface, but no distinct vascular appearance. It is usually congenital, or has been noticed in early childhood ; and it continues without any very material change in shape, size, or appearance, until the inconvenience or deformity occasioned by it necessitate its removal. This is best effected by the knife. After removal, the tumour will be found to be composed of a mass of fibrous fat, having a large number of veins ramifying through it, so as to constitute a distinct vascular element, often communicating with small cysts containing a bloody fluid. The tumour has occasionally a tendency to recur after removal. In one case I operated three times for the removal of a large growth of this description, situated on the buttock, and extending forward towards the perinæum. The first operation was performed in 1851 ; the second in 1856 ; and the patient, then eighteen years of age, again presented himself in 1863 with a recurrence of the growth in an ulcerated state, in the cicatrix of the former operations. The situation in which I have seen such tumours occur, where they gave rise to most inconvenience, and where their removal has required the greatest care, has been the anterior part of the thigh, just below Poupart's ligament, close upon and almost in connection with the femoral vessels. In a case of this description, which was sent to me by Edwards of Antigua, the patient, a gentleman of that island, had suffered for some years from a chronic solid œdema of one of his legs, apparently dependent upon the pressure exercised upon the saphena and femoral veins by an elongated indolent tumour just below Poupart's ligament, and over the course of these vessels. This tumour had existed from childhood, and presented the signs that have just been given as characteristic of the disease under consideration. It was removed by an incision parallel to Poupart's ligament, some careful dissection being required to separate it from the femoral sheath, more particularly towards the inner side, where a prolongation of the tumour dipped down by the side of the femoral vein, compressing that vessel, and thus causing the œdema of the limb. After removal, the tumour was found to consist of a mass of dense adipose tissue, with much vascular structure intermixed, and some small cysts. The œdema gradually subsided ; and when the patient left England, about three months after the operation, the limb had nearly regained its normal size.

HÆMORRHAGIC DIATHESIS, OR HÆMOPHILIA.

In connection with diseases of the blood-vessels it may be stated that in some constitutional conditions it is found, though fortunately very rarely, that there is a great tendency to very troublesome, indeed almost uncontrollable bleeding, from slight wounds. An abnormal tendency to bleed is sometimes observed in persons who are "out of condition," and whose tissues are soft and flaccid. They bleed freely from slight wounds and bruise extensively from trivial blows. In these cases the bleeding appears to be maintained by the laxity of fibre preventing the proper contraction of the divided or torn vessels : and the tendency to hæmorrhage will vary at different times in the same person according as the state of his health improves or deteriorates. In other cases abnormal bleeding may be due to a diminution in the normal coagulability of the blood. This state is sometimes met with in scurvy, chronic jaundice, and albuminuria. The disease known as Hæmophilia or Hæmorrhagic Diathesis is quite independent of such conditions as these. It is a peculiar constitutional state always congenital, and most frequently hereditary, especially in the male line. In some families the males only have been affected, and the diathesis has been transmitted in the second or third generation through females ; who, themselves being unaffected by it, have had male children who were the subjects of the disease. The diathesis occurs in persons without any other apparent derangement of health, or morbid condition, innate or acquired, to account for it. In such cases the family peculiarity is usually recognized, and well known to those liable to it.

The only constant sign of the diathesis is the free and often almost uncontrollable bleeding that takes place from trivial wounds ; life being put in jeopardy and even lost by the hæmorrhage resulting from the extraction of a tooth, the opening of an abscess, lancing the gums, or some equally slight unimportant surgical procedure. The blood does not flow in a jet, but continues to trickle in an oozing stream, apparently from the capillaries rather than from the larger vessels of the part. In these cases also there is a great tendency to extensive ecchymosis from very slight contusions.

In these families of bleeders, it is scarcely necessary to say that it is imperative to be careful to make no surgical wounds, even of the most trivial character, if they can possibly be avoided. Above all, the extraction of teeth must be avoided. It is after this slight operation that the most uncontrollable and fatal hæmorrhages have occurred. The hæmorrhages, though usually traumatic, may be spontaneous ; they then usually proceed from the nose, bowel, kidney, or subcutaneous connective tissue. In women they assume the character of profuse and uncontrollable menorrhagia. The hæmorrhages are accompanied by the symptoms described at p. 403, Vol. I., as characterizing excessive loss of blood ; and after their cessation the patient remains anæmic usually for many weeks or months. The quantity of blood lost is often enormous, amounting in some cases to several pounds in the twenty-four hours.

The tendency to bleeding is chiefly from recent wounds or healthy mucous membranes, and sometimes does not occur from diseased surfaces from which it presumably would be likely to happen. Thus a member of one of the three families of bleeders, who have been frequently inmates of University College Hospital, died lately of phthisis, with large cavities of the lungs. A few weeks before his death he had nearly died of hæmorrhage after the extraction of a tooth, but he had never suffered from serious hæmoptysis. In another case the patient passed through an attack of typhoid fever without serious hæmorrhage. In another a large slough formed in the skin after the application of perchloride of iron, cold and pressure to arrest hæmorrhage from a punctured wound of the leg, yet the slough separated, and the large granulating sore healed without any recurrence of the bleeding.

Formerly it was supposed that females were exempt from hæmophilia. But Wickham Legg, to whom we are indebted for an excellent monograph on this condition, states that this assumption can no longer be maintained, although women are far less disposed to the disease than men ; that they present few instances of the more typical forms of the disease ; and that it is less fatal in them than in men. Most of the fatal cases in women have occurred by hæmorrhage from the genital organs, and Legg quotes a case from Wachsmuth, " where the rupture of the hymen on the marriage-night caused the death of the bride from hæmorrhage."

A frequent symptom accompanying this diathesis is a painful and sudden swelling of one or more joints either occurring spontaneously, or as the result of some slight injury. The swelling is the result of an effusion of blood and synovia into the synovial membrane. It is usually accompanied by some slight febrile disturbance. It may last only a few days or may endure for months. The joint is often permanently weakened, and relapses are frequent during the cure.

Pathology.—Little if anything is known with certainty about the nature of this peculiar affection. It has been stated that in some cases the inner coat of the arteries has been found abnormally thin, and degenerative changes have been observed in the endothelium, but the observations are not sufficiently numerous or uniform for any theory to be founded upon them. From the influence exerted by cold in the arrest of the bleeding, it may be reasonably suspected that a want of proper contractility in the arteries may have some influence in causing the bleeding. With regard to the condition of the blood, varying statements have been made ; it has been said to be watery, deficient in corpuscles, and uncoagulable. In the cases however which have been admitted into University College Hospital, the blood in the earlier stages of the hæmorrhage coagulated healthily and was of good colour, though after great loss the tint became paler and the coagulum less firm. Accurate analyses of the blood from bleeders are still wanting. It has been suggested as another explanation of the disease that its real cause is an excess of blood, but of this also there is no definite evidence. It would appear then that the only facts of importance that we at present possess to throw light on the cause of hæmophilia are, that it is hereditary ; that it is far more frequent in males than in females ; and that it is congenital, and may occur in all races and in all countries.

Treatment.—In true hæmophilia no remedies appear to exercise the slightest influence over the diathesis. At the same time, it would be wise for the subject of this unfortunate condition to attend to those ordinary rules of health, the neglect of which, by lowering his "condition," might favour the tendency to bleed. Legg especially recommends the use of cold baths of plain, sea, or chalybeate waters, residence in a dry air, and the use of warm clothing. The preparations of iron are usually given in a routine way, but it is doubtful if they have ever been of service in preventing the hæmorrhages; they certainly never have arrested them, though they may be of use in removing the anæmic state left after a copious bleeding. Ergot has been given during the bleeding in many cases, but without evident effect.

The *Local Treatment* is that on which most dependence will necessarily be placed. It consists in the use of three means—viz., Pressure, Styptics, and Cold.

Pressure is to be relied on only in one form of hæmophilic bleeding—viz., the continuous hæmorrhage from the socket of a tooth after extraction. In these cases the cavity should be cleared out and carefully plugged from the bottom by means of lint or agaric, the whole retained by means of a piece of cork and a gutta-percha cap to fit over the neighbouring teeth, and compressed by a bandage applied under the chin against those in the sound jaw. When the hæmorrhage occurs from the soft parts, pressure must be used with great caution lest sloughing occur; the integuments being extremely liable to give way extensively under very moderate pressure, large subcutaneous extravasation developing at the same time, and thus increasing materially the danger of the case and the local mischief.

Compression of the main artery of the limb is useless and liable to the objection that it may cause the development of ecchymoses and subcutaneous hæmorrhages.

Styptics of all kinds have been used as a matter of course, and the perchloride of iron has enjoyed especial favour. I have used and seen it used frequently, and can safely say that I have never seen any permanent benefit from its application, or that of any other styptic, in these cases. Indeed, great evil has often resulted from the inflammation excited by the application of styptics of any kind. The parts become swollen, fall into slough, and as they separate the oozing may recommence from the raw surface, and the same process has to be gone through again.

The **actual Cautery** presents the same disadvantages as ordinary styptics. It may temporarily arrest the bleeding, but inflammation is set up in the parts beyond the limit of the eschar, and this on separating leaves an extended ulcerating surface which may bleed again, perhaps more freely than before.

The continued application of **Cold** appears to arrest hæmophilic bleeding more effectually than any other means, and this circumstance would lead to the belief that the hæmorrhage is due to want of contractility in the smaller arteries rather than to want of coagulability in the blood. The cold may be applied by means of irrigation of iced water, as has been done successfully by Marshall, or by the application of ice either directly to the part or laid upon a sponge covering it, as has been done in some of the cases of hæmophilia occurring at University College Hospital. Simple water may be used, or a weak antiseptic solution of boracic acid. If the bleeding wound be in the extremities, the limb should be elevated and kept at rest on a splint.

The Surgeon has already been cautioned as to the inexpediency of performing any operation, except under circumstances of the most urgent necessity, on any member of a family of bleeders, or on an individual known to be the subject of hæmophilia. Should an operative procedure become necessary, it should, if possible, be undertaken with Paquelin's thermo-cautery, or the galvanic écraseur. In the event of these not being at hand, the *elastic ligature* would be the best substitute.

CHAPTER XLII.

DISEASES OF ARTERIES.

Arteries are liable to numerous diseases which derive great importance from the effects they produce, both upon the vessels themselves and upon the parts to which they carry blood. Amongst the most important are the various forms of inflammation or arteritis. The inflammatory affections of arteries are divided first into two classes, viz., those resulting from injury, and those arising from general or local causes not of a traumatic nature. Inflammation of the arteries is divided also into endarteritis, in which it affects primarily or chiefly the internal coat, and peri-arteritis, in which the process commences in the outer coat or sheath. The term "mes-arteritis" has also been suggested for inflammation of the middle coat, but it is of little use, as no true inflammatory affection commences in that part of the vessel. Some forms of arteritis are named from the cause of the disease, as syphilitic or embolic. As in other structures, the inflammatory process may be acute or chronic. In addition to the above diseases, arteries suffer from various degenerative changes, some of which are primary, affecting the original tissues of the vessels, others are secondary, the degeneration taking place chiefly in the products of a chronic inflammatory process. These various processes are still further complicated by secondary effects, such as the formation of aneurism, from the diseased walls of the artery yielding before the pressure of the blood, and thrombosis of the affected vessel followed by its obliteration, and sometimes by embolism and gangrene.

In discussing the diseases of arteries, it will be most convenient to consider first the various forms of inflammation; secondly, the degenerations; and lastly, the more remote effects of these changes.

ARTERITIS.

Acute Arteritis of idiopathic origin, that is to say, arising as an independent affection for which no evident cause can be found, was formerly believed to be a comparatively common disease. It was supposed to affect the inner coat, spreading along the vessel in the direction of the circulation, and from this fact it was spoken of as diffuse or erysipelatous. It is now known, however, that no such affection really exists, and that the error arose partly from assuming that thrombosis is invariably evidence of previous inflammation of the affected vessel, and partly from mistaking for the redness of inflammation the staining of the intima, so often observed as the result of changes in the blood with disintegration o the red corpuscles, which may occur during life in acute forms of blood-poisoning such as septicæmia or malignant fevers, or after death as the result of putrefaction.

Traumatic Arteritis.—Simple acute traumatic inflammation limited to the part injured and showing no tendency to extension, is familiar to every

Surgeon in connection with contusion, laceration, wound, or ligature of arteries ; for in the early period of repair after any of these injuries, inflammatory exudation from the vasa vasorum forms an essential part of the process. For a description of this condition, the reader is referred to Vol. I., Chap. XIV.

Arteritis by Extension, from infective inflammation or ulceration of the tissues surrounding the vessel, has already been described as one of the dangers accompanying these processes. In inflammation affecting an artery in this way, the process is the same as in other tissues. The vessels of the outer coat are dilated, inflammatory exudation with migration of corpuscles takes place, and the wandering cells infiltrate the coats of the artery, which become swollen and softened. The process spreads from the outer to the inner coat, the endothelium separates, and fibrin is deposited upon the diseased surface. In the smaller arteries complete thrombosis takes place, and the clot extends upwards to the nearest branch beyond the inflamed part of the vessel, and may then undergo the changes already described as occurring in the permanent closure of an artery (Vol. I., Wounds of Arteries), and hæmorrhage is thus prevented. In arteries above the size of the radial, however, the closure of the vessel is frequently not accomplished before the coats are so far softened as to give way before the pressure of the blood, and thus fatal hæmorrhage may result. This is all the more likely to occur when the inflammation and subsequent ulceration affect a limited portion of one side only of the artery, as in those cases in which it is due to the contact of an irritating foreign body, such as a sequestrum. In the larger arteries complete thrombosis occurs much less readily than in smaller vessels or in veins, the rapidity of the flow of the blood being unfavourable to the adhesion of the white corpuscles which is the first step in thrombosis.

In arteries which have been divided and secured by ligature or otherwise, the extension of unhealthy inflammation from the wound to the exposed end of the vessel, followed by softening of its coats, and disintegration of the contained clot is the commonest cause of secondary hæmorrhage.

Embolic Arteritis.—Moxon has pointed out that a form of acute arteritis, resulting in softening and swelling of the arterial wall, thus leading to the formation of an aneurism or to rupture of the vessel, is in rare cases the result of the lodgment of an embolus. A simple fibrinous embolus lodging in an artery merely obliterates the vessel without causing softening of its coats. In order that inflammatory softening may occur, it is necessary that the embolus should be derived from a part which is the seat of some infective inflammation, and that it should carry with it the unhealthy products of the process. Embolic arteritis is most likely to occur in the somewhat rare affection known as ulcerative or infective endocarditis, but it has also been known to follow embolism during the course of an ordinary case of acute rheumatism. Localised arteritis arising in this way is believed to be the most common, if not the sole cause of spontaneous aneurisms in children, and in the smaller vessels of the extremities in adults. Rushton Parker has recorded a case which well illustrates this form of disease. A boy, aged 14, during an attack of acute rheumatism was suddenly seized with pain in the forearm, followed by swelling of the limb. The general swelling soon subsided, leaving a deeply seated circumscribed tumour, which steadily increased in size for the next four months. On laying this open a cavity was exposed containing more than a pound of dark clotted blood, and the anterior interosseous artery was found to communicate with it by an opening a quarter of an inch in length. The vessel was successfully ligatured above and below the opening, and the boy recovered. At the time of the operation there was a loud double aortic murmur. Langton and Bowlby have recorded a case in which as a consequence of the lodgment of emboli from the valves of the heart in ulcerative endocarditis false aneurisms formed at the bend of the elbow and in the popliteal space, necessitating the ligature of the brachial and femoral arteries. The patient died eight weeks afterwards from the effects of an embolus lodged in the brain.

Acute Endarteritis.—Cornil and Ranvier describe under this name an affection of the inner coat, met with chiefly in the aorta, but occasionally also in smaller vessels, especially near wounds. It is characterized, to the naked eye, by prominent patches formed by a swelling of the intima. They are circular or oval in outline, and seldom exceed half an inch in diameter, though both their form and size may be altered by the coalescence of neighbouring patches. They are pale pink in colour, and semi-transparent or opalescent ; in consistence, they are soft and elastic, almost gelatinous. The internal surface has often lost its polish, in consequence of the irregularity of the swelling, but its endothelial covering is usually intact. The middle coat beneath the patch appears usually to be somewhat swollen, and this condition is more marked in the adventitia. Microscopic examination shows that the swelling is due to an accumulation of small cells, either round or slightly irregular in outline, between the fibres of the sub-endothelial connective tissue and the elastic layers of the inner coat. These cells have a distinct nucleus surrounded by a small quantity of protoplasm, and show signs of active growth. Cornil and Ranvier believe they are produced by proliferation of the original cells of the part. The swelling of the external coat is found to be due to the presence of numerous cells of new formation separating the fibres of the connective tissue.

The conditions under which acute endarteritis occurs are not clearly determined, but as every intermediate condition between it and the chronic form to be immediately described, is to be met with, sometimes even in the same vessel, it seems to be nothing more than the same process increased in intensity.

Chronic Endarteritis, Arteritis Deformans, Atheroma.—This is by far the most common disease to which arteries are liable, in fact, it is very rare after middle life to find it completely absent in the larger vessels. It occurs in its most marked form in the aorta and the large arteries of the neck, abdomen, the upper parts of the limbs and the base of the brain. It is less commonly seen in the smaller vessels, in which the muscular coat is more fully developed.

Chronic endarteritis first appears as pale yellowish patches or streaks, smooth, slightly elevated above the surface, and evidently seated in the deeper layers of the inner coat. They are irregular in outline, their long diameter is usually in the line of the vessel's course, but they show a special predilection for the mouths of the branches leaving the main trunk, round which they form annular elevations. Their outline becomes subsequently more irregular by the coalescence of neighbouring patches. As the disease advances, the patches become more elevated, often reaching a line or more in thickness

At this stage they are grey, semi-transparent or opalescent, and inelastic, sometimes almost cartilaginous in appearance and consistence. This condition is, however, speedily followed, before the patches have reached more than half an inch in diameter, by a change to an opaque yellow colour, the alteration in tint commencing in the central parts. This change is due to fatty degeneration, and is accompanied by some loss of toughness. The further progress may be in one of two directions; the growth may soften and break down, or it may calcify. When softening takes place the patch becomes converted into a pultaceous or cheesy mass, and even sometimes undergoes complete liquefaction into a yellow creamy fluid, which has been mistaken for true pus, and termed an "*atheromatous abscess.*" It is this change that led to the term "atheroma" being applied to the disease, the products of the softening of the patch resembling the contents of an atheromatous cyst of the skin. The term is now often extended to all stages of chronic endarteritis.

When the process reaches the more advanced stages the middle coat is affected, first by chronic inflammation, and subsequently by softening. At the same time considerable thickening of the external coat takes place by the formation of dense fibroid tissue which is not prone to fatty degeneration and softening. Up to this point the fatty patch is covered by the most internal layers of the intima and the endothelium, which are not affected by the chronic inflammatory process, but after complete softening these give way, and the atheromatous fluid is discharged into the circulation, leaving the remains of the patch exposed to the blood-stream. The raw surface thus formed is called an "*atheromatous ulcer.*" The débris which enter the circulation are carried on and lodge in the capillaries, but not possessing any irritating properties they give rise to no evil consequences. Although on the formation of an atheromatous ulcer a considerable part of the inner and middle coats is lost, perforation or rupture of the artery rarely takes place, and it is only in exceptional cases that the blood forces its way amongst the coats of the diseased vessel. This is due to the fact that at the margins of the patch, the chronic inflammatory process has led to firm matting together of the coats of the artery. At the same time the thickening and induration of the external coat prevents perforation. It is especially opposite the deeper and more eroded atheromatous patches that this consolidation of the external coat takes place. The change, although described as a chronic inflammation, is strictly conservative in character. The new growth of fibroid tissue is not confined to the external coat, but extends to the sheath of the vessel, and, by soldering it to the contained artery, greatly adds to the strength of the vascular wall.

Although perforation is thus prevented, the new tissue but imperfectly represents the normal structures of the coats of an artery, as it is entirely wanting in elasticity. Consequently it is very apt to yield slowly to the pressure of the blood, and thus lead to the formation of a sacculated aneurism, the mouth of which will correspond to the damaged portion of the wall of the vessel.

Complete softening, with the formation of an atheromatous ulcer, is not by any means a necessary consequence of fatty degeneration of the patches resulting from chronic endarteritis. In many cases the new tissue, after degenerating, remains as a firm, yellow, opaque mass, and may undergo no further change, but most commonly lime salts are deposited in it, and it gradually becomes converted into a hard calcareous plate, over which the superficial layers of the inner coat with the endothelium may remain unbroken. Sometimes, however, these seem to wear away and the calcareous plate comes in direct contact with the blood-stream. This change was formerly described as "*ossification of the arteries*," but it need not be said that no true bone is formed. From the arrangement of the calcareous matter in plates corresponding to the atheromatous patches in which the lime salts have been deposited, this change has also received the name of *laminar calcification.*

Microscopic examination of an atheromatous artery in the early stage of the disease shows that the morbid change commences in the deeper layers of the inner coat by a proliferation of the flattened cells that lie between the laminæ of connective tissue of which it is chiefly composed. The new cells are arranged in lines between the laminæ. With the proliferation of the cells there is a growth of new laminæ of connective tissue closely resembling that of the healthy inner coat, both in appearance and in arrangement. The change is therefore a true overgrowth of the deeper layers of the intima. The relative amount of cells and fibrous intercellular substance varies in different cases, but the chief bulk of the new tissue is always composed of the latter. The cells are small, rounded or slightly flattened and contain a nucleus of considerable size, round which it is often difficult to recognize any protoplasm. No vessels penetrate the new tissue and consequently when it reaches a certain stage of development the central parts are but imperfectly nourished, and degeneration commences. The cells become shrivelled and granular, and fatty granules also appear in the intercellular substance. At a later stage calcareous granules may also make their appearance. If softening takes place, the fat-granules increase in quantity, and solution of the intercellular substance follows. If complete liquefaction takes place the atheromatous fluid is found under the microscope to be composed chiefly of fatty débris and oil-globules, and very frequently it contains plates of cholesterine (Fig. 439). The accompanying drawing (Fig. 440), illustrates the structure of an atheromatous patch very well.

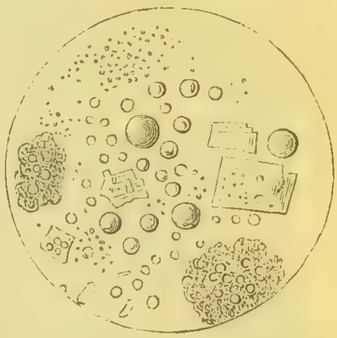
Fig. 439.—Atheroma, with abundant Cholesterine.

The changes in the middle and outer coats require but little notice. The middle coat in the later stages is often invaded by a growth similar in character and structure to that which originally started in the inner coat. In fact, it seems to be an extension of the same growth, the true structures of the middle coat being atrophied from pressure. The outer coat shows a growth of new fibrous tissue containing a number of small round, or elongated cells.

Nature and Causes.—The views as to the nature of the disease have undergone various changes, but at the present time it is almost universally regarded as a chronic inflammatory process, characterized by overgrowth of the affected tissue followed by degeneration. Gulliver was long ago inclined to this opinion, and it has been especially insisted on by Virchow, Billroth, and Moxon. That it belongs to the class of morbid processes almost universally spoken of as chronic inflammations, may be said now to be generally accepted, but the difference between these and acute inflammation is so marked that probably, with the advance of pathological knowledge, a complete separation will be made between them.

The most important cause of chronic endarteritis is mechanical strain. This may be constant, as the result of abnormal resistance in the capillaries or smaller arteries, or intermittent, such as occurs during violent exertion, in which, while the heart is beating forcibly, the resistance to the circulation is increased by the contraction of the muscles. Moxon has brought forward abundant evidence in proof of this theory. He points out that atheroma occurs more constantly and at an earlier period in males than in females, and that when extensive atheroma is met with in women, it will usually be found that they have been engaged in hard manual labour. In men, the most marked examples are met with in those whose occupations have involved violent physical exertion. In wasting diseases, in which the quantity of blood is diminished and the arterial tension reduced, atheroma is seldom met with, and in the pulmonary arteries, in which the pressure is greatly less than in the systemic vessels, chronic endarteritis is rare, being observed only in those cases in which the right heart is hypertrophied in consequence of chronic bronchitis and emphysema, or obstruction at the mitral orifice. The earliest patches of atheroma are moreover situated in the parts exposed to the greatest strain, as in the arch of the aorta, and at the points at which large branches are given off or a trunk bifurcates. It is common also to find the disease more advanced in those situations in which the artery is placed in close proximity to a bone, as in the femoral at the brim of the pelvis. The fact that chronic endarteritis is always more marked in the vessels of the lower limb than in those of the upper may also be explained by the pressure being greater in the most dependent parts while the body is in the erect position.

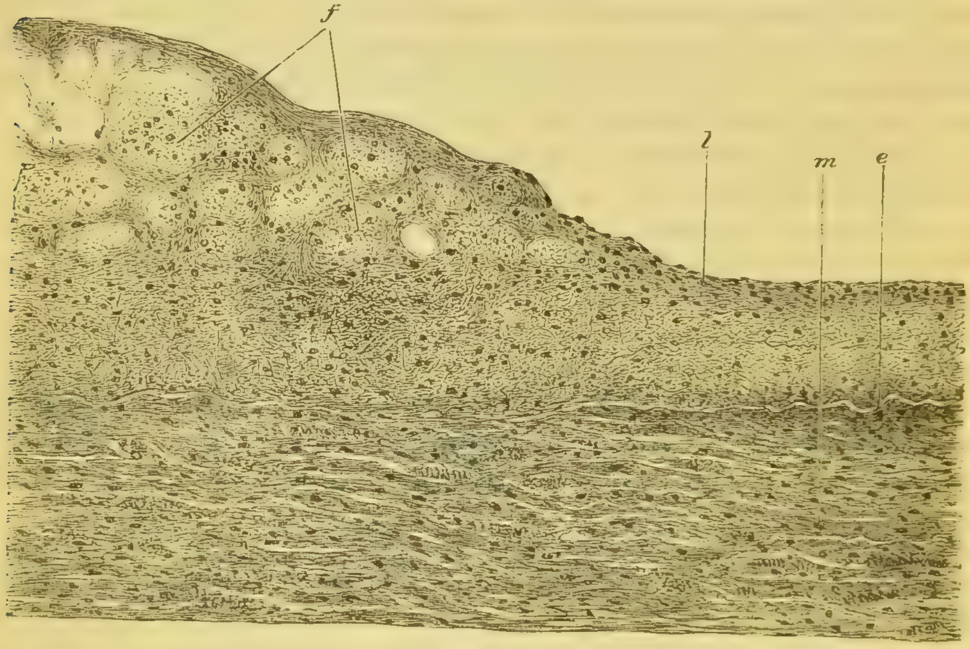

Fig. 440.—Atheroma of Aorta. *e*, elastic lamina : *m*, middle coat ; *l*, internal coat ; *f*, the new growth undergoing fatty degeneration.

Among the constitutional affections which predispose most powerfully to the development of atheroma is chronic Bright's disease, with the granular contracted kidney. Gull and Sutton have demonstrated that this disease is associated with a general change in the smaller arteries and capillaries to which they have given the name of *arterio-capillary fibrosis.* It is characterized by a fibroid thickening of the external coat of the smaller arteries. In the diseased kidney, Johnson has described a thickening of the walls of the smaller arteries, which he believes to be due chiefly to the hypertrophy of the muscular coat. The nature of these changes and their extent is still a matter of dispute ; but whatever the exact pathological change may be, it is beyond a doubt that it causes considerable obstruction to the circulation, a fact which is proved by the hypertrophy of the heart that accompanies the disease and the evidence of increased arterial tension as indicated by the sphygmograph.—The granular contracted kidney and the general vascular changes associated with it are very commonly the result of *gout*, so much so that this form of Bright's disease is often termed the "gouty kidney." Gout is usually the result of an abuse of alcoholic stimulants, and thus habitual alcoholic excess comes indirectly to be an important cause of chronic endarteritis.

The influence of *syphilis* in the causation of atheroma is a more doubtful point. Aitken attaches great importance to it. The effect of syphilis in causing disease of the smaller arteries, and fibroid induration of organs and tissues has already been pointed out (see Syphilis, Vol. I.), and it is evident that these changes would tend to obstruct the circulation and thus cause increased arterial tension. Whether it acts more directly as a cause of atheroma is uncertain.

The most important predisposing cause of chronic endarteritis is *old age.* After a certain period of life the arteries in common with other tissues become impaired in structure. This manifests itself chiefly by a diminution in the normal elasticity of the coats, so that they become less capable of withstanding any strain to which they may be subjected. So frequent, and indeed constant are these transformations of the arterial coats during the decline of life, that they may be considered the natural result of the diminution of the nutrient activity consequent upon advance in years. Gmelin has found that there is a progressive increase in the earthy matters contained in the coats of healthy arteries as the individual advances in life. Thus he ascertained that the ash of the arteries of a newly-born child yields 0·86 per cent. of phosphate of lime ; the healthy arteries of an adult 1·25 ; and those of an old man 2·77 of the same salt ; whilst the calcified arteries of an aged man contain 4·01. There is no precise period of life at which these changes set in ; old age is a relative term, and, as soon as the system has passed its full maturity, in whatever year of life this may happen, there is a tendency for these degenerative changes to take place. The tendency to early degeneration of arteries is frequently hereditary.

Effects of Chronic Endarteritis.—As a consequence of the loss of elasticity resulting from the chronic inflammatory and degenerative changes in the coats of the artery, it usually yields more or less before the distending force of the heart. This change is most marked in the aorta and its primary divisions, but is occasionally seen in the femoral and brachial arteries. The dilatation may be regular, or pouch-like projections may form here and there. At the same time the vessel is often somewhat elongated so as to assume a tortuous form. It is in consequence of these changes that the name *arteritis deformans* was given to this disease by Virchow. The interior of the dilated vessel is rough and irregular in consequence of the projection of the atheromatous patches; when softening has taken place, "atheromatous ulcers" may be scattered here and there over the surface, and in other cases it may be paved with closely-set calcareous plates. When the dilatation reaches a certain degree and is limited to a definite area, the condition is described as a fusiform aneurism, the distinction between that and simple dilatation being only one of degree (see Aneurism).

The loss of elasticity in the coats seriously interferes with the circulation through distant parts, as the natural storage of the heart's force in the elastic walls of the larger vessels by which the continuous flow between each systole is maintained, is no longer possible. The circulation in the extremities is, therefore, usually feeble, and the nutrition of the parts correspondingly imperfect.

Narrowing or Occlusion of the Branches leaving the Atheromatous Trunk is by no means uncommon. As before stated, the orifices of the branches from the main trunk are common seats of the earliest atheromatous patches. The thickening of the intima may take place in a ring round the mouth of the vessel and thus gradually narrow it. The coincident thickening of the outer coat may still further contract the orifice. When complete obliteration occurs the final obstruction probably takes place by the formation of a thrombus in the diseased artery immediately above the narrowed orifice. Complete obliteration is most common in those cases in which the dilatation of the main trunk has reached such a degree as to merit the name of a fusiform aneurism. In a case in University College Hospital a few years ago, in which the left carotid was tied for aneurism of the inominate artery and the arch of the aorta with an immediately fatal result, it was found that the right subclavian was obliterated where it left the dilated inominate, the right carotid was pervious, but pressed on by the aneurism, and the aortic opening of the left subclavian was completely closed; thus the artery which was tied was the only vessel carrying blood to the brain. Narrowing of the coronary arteries by an atheromatous ring at their orifices is a common cause of fatty heart.

Thrombosis is an occasional consequence of atheroma. So long as the patch is covered by an unbroken layer of the inner coat with its endothelial covering, there is no tendency for coagulation to take place upon it. When, however, the patch has softened and discharged into the circulation, leaving an "atheromatous ulcer," or when the thin covering over a calcareous plate has been worn away, the diseased structures come into direct contact with the blood. If the surface is tolerably smooth, the rush of blood past the diseased patch is so rapid that adhesion of the corpuscles is barely possible and consequently no thrombosis results; but in pouch-like dilatations it readily takes place. In the same way it may occur in a very dilated vessel if the heart's action is unusually feeble. A clot thus formed may gradually increase in size till it fills the whole vessel, but more commonly after reaching a certain bulk it is washed away and carried on as an *embolus* to some distant part. If it be of sufficient size to obstruct a main artery of one of the limbs at its bifurcation, gangrene will frequently result. Smaller fragments lodging in the extremities usually produce no important effects, the anastomosing circulation being sufficient to take the place of the obstructed vessel. If lodging in one of the solid viscera, it gives rise to a hæmorrhagic infarct (see Vol. I., p. 983), but does not as a rule cause any serious consequences.

Syphilitic Endarteritis has already been described (Vol. I., p. 1126).

Arteritis Obliterans or **Obliterative Arteritis** (Friedländer) : **Endarteritis Proliferans** or **Hyperplastic Endarteritis** (Von Winiwarter).—Under these names have been described certain rare cases in which obliteration of arteries takes place as the result of inflammatory changes in their coats, not evidently dependent on syphilis, embolism or injury. The disease runs a chronic course, and may cause spontaneous gangrene of the parts supplied by the affected vessel. The symptoms will perhaps be best illustrated by quoting a typical case lately recorded by Pearce Gould. The patient was a brickmaker, aged 19. In May, 1883, the fingers of his right hand became congested and sometimes dead white, with much sickening pain. After a few weeks' rest he improved, but soon relapsed on returning to work. After some months the pain extended into the forearm, and completely incapacitated him from working. He came under Gould's observation in October, 1883. At that time the right forearm and hand were cold and somewhat wasted, and he suffered much pain, especially at night. The brachial artery was harder than natural, and pulsated more feebly than on the opposite side. The radial could be felt as a solid cord. There was dry gangrene of the tips of three fingers. No constitutional affection was found to account for the condition. Two weeks afterwards the pain increased till it became agonizing, requiring hypodermic injection of morphia for its relief. At this time there was slight elevation of temperature. The brachial artery then became converted into a pulseless cord to within one inch of the teres major. Soon after, the subclavian artery was found to be prominent. In December the pain gradually subsided, and one month after he was apparently well. The brachial artery remained a solid cord, and the first joint of the thumb and that of the index finger separated after becoming mummified (see Trans. Clin. Soc. 1884). This patient was exhibited again in October, 1886. He had worked as a labourer till the previous April when he was attacked with numbness of the right arm and severe headache which had persisted ever since. In June he suddenly lost power in the left arm, and became unconscious the same evening. From this attack he slowly recovered. In October the right axillary and subclavian could be felt as a hard pulseless cord, and there was no pulse in any of the vessels of the limb, which was cold and slightly wasted. There was no pulsation in the right temporal, but the carotid seemed to be healthy. A somewhat similar case occurring in a female, aged 35, was recorded by W. B. Hadden in 1884. The pathology and causes of this rare affection are still uncertain. It commonly occurs about middle life, Gould's case being the youngest recorded.

The disease described by Von Winiwarter under the name of endarteritis proliferans is probably of the same nature. He states that it occurs in persons apparently healthy in other respects, and gives rise to spontaneous gangrene, usually of the foot. In one case in which the vessels were examined after amputation of the limb the obliteration was found to be the result of a great proliferation of the endothelium, narrowing of the lumen of the vessel, the final obliteration being brought about by thrombosis. New vessels were found penetrating from the outer coat into the proliferating endothelium, which with the thrombus was found in the older parts to be undergoing changes similar to those already described as occurring in closure of an artery after ligature. Billroth states that the disease is preceded by feebleness of circulation, and obscure pain, often lasting for months or years. There is no definite treatment for these cases.

Periarteritis.—By periarteritis is meant an inflammation commencing in the outer coat or sheath of the artery. If we exclude arteritis by extension from surrounding tissues and traumatic arteritis, periarteritis is a rare disease. Charcot and Bouchard have described such an affection in the vessels of the brain, commencing as an accumulation of small round cells in the perivascular sheaths ; these penetrate the coats from without and lead to softening, frequently followed by the formation of minute aneurisms and final rupture. It is a senile disease, and according to Charcot a common cause of apoplexy.

An affection of the arteries of an uncertain nature not causing obliteration has been observed, which, from its giving rise to acute pain and tenderness with some swelling in the line of the vessel, must be supposed to be inflammatory. A case of this kind has been recorded by J. H. Morgan, in the Transactions of the Clinical Society for 1881. The patient, a man aged 46, was attacked with severe pain in the line of the right femoral artery ; the vessel was acutely tender, but there was no redness of the skin covering it. The condition was at first limited to a few inches of the artery near the groin, but gradually extended to the popliteal space and leg. Slight œdema and some swelling of the lymphatic glands became apparent when the disease reached the leg. The vessel pulsated forcibly and there was no thrombosis. He had some years previously suffered from a similar affection of the opposite leg, and while still under observation, the right brachial and carotid were successively affected. Altogether the second attack lasted over five months. It was not apparently due to syphilis, gout, or rheumatism. From the absence of thrombosis it would seem probable that the disease was a periarteritis.

PRIMARY DEGENERATIONS OF ARTERIES.

Fatty Degeneration.—Fatty degeneration, except as a part of chronic endarteritis, is not a particularly frequent or important change in arteries. In the aorta, even in young subjects, yellow patches of small size and irregular form, and very slightly if at all elevated above the normal surface of the intima, are common. If one of these be peeled off and examined microscopically it will be found to present stellate patches of fat-granules in the most superficial layers of the intima, immediately beneath the endothelium. These are the result of fatty degeneration of the branched cells that are normally present in this part. The affection seems of no importance, and its cause is not known.

In later life, fatty degeneration affecting the intima more deeply is sometimes met with unaccompanied by any of the signs of atheroma. The degeneration may extend to the endothelium, which then disintegrates and is cast off, leaving a rough surface exposed. This condition has been described as *fatty erosion.* It is most common in the arch of the aorta. Through such a surface the blood may force its way into the middle coat, and thus give rise to the condition to be subsequently described as "*dissecting aneurism.*"

Fatty granules are not uncommonly found in old age in the external coats of the smaller arteries, but they are of no pathological importance.

Calcification or Calcareous Degeneration.—We have already seen that the calcareous plates so common in the aorta and its primary branches are the result of the calcification of the products of chronic endarteritis. In the smaller arteries, principally in those of the third and fourth magnitudes, as the popliteal, the tibials, the brachial, radial and ulnar, primary calcification is commonly met with. It commences by the deposit of lime-salts, in a granular form, arranged in lines running transversely to the axis of the vessel; these lines gradually increase in breadth until they coalesce laterally, the intervening spaces being filled up and the vessel converted into a rigid tube. In the early stages while the calcareous matter is arranged so as to form lines round the vessel, the condition is termed *annular calcification* (Fig. 441). When these lines have coalesced it is often called *tubular calcification* (Fig. 442).

When this process has reached its highest stage, if the artery be removed from the body and drawn through the fingers, a small rigid tube, composed of the calcified middle coat still lined by the inner coat, can be squeezed out, leaving the external coat apparently healthy. In fact, the toughness of the external coat is so little impaired that such a vessel can be tied, and even twisted, almost as safely as a healthy artery. Annular and tubular calcification are almost invariably associated with chronic endarteritis, and its secondary degenerations in the larger vessels, and in the intermediate arteries, such as the axillary or popliteal, and sometimes even as low as the tibials, both conditions are observed side by side.

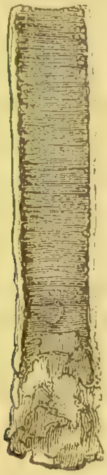
Fig. 441.—Annular Calcification.

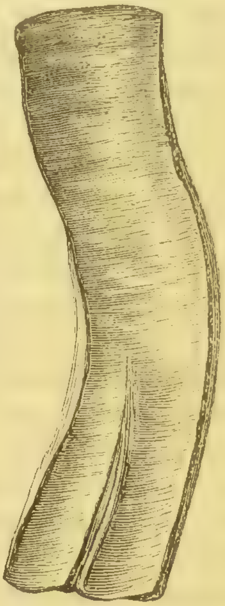
Fig. 442.—Tubular Calcification.

The existence of this degenerative change is usually recognized without difficulty during life in any artery that can be examined with the finger. The vessel feels hard and less compressible than natural. Its longitudinal elasticity is lessened, so that it is thrown into a wavy line when relaxed longitudinally by flexion of the limb.

The morbid condition consists essentially of a deposit of lime salts in the muscular fibre cells of the middle coat. We thus meet with it only in those vessels in which the muscular tissue is well developed. In the larger arteries the muscular cells are so scanty and so far concealed by the elastic tissue that if this change does occur in them it is difficult to recognize. The inner coat in the larger vessels usually shows the ordinary signs of chronic endarteritis. In the smaller it may at first be healthy, but later on calcareous plates may form in it. It has been pointed out by Bizot that the symmetry of the arrangement of these morbid appearances in the corresponding vessels on opposite sides of the body is remarkable, the arteries of one limb being often the exact counterpart in this respect of those of the other.

The causes of calcification of the muscular fibre cells of the middle coat, are unknown beyond that it is always a senile change.

The effects of annular calcification are to render the vessel a rigid tube no longer capable of regulating the flow of blood to the parts it supplies. At the same time its calibre is always diminished, and the nutrition of the parts beyond is seriously impaired. Thus in the limbs we have all the signs of defective circulation, coldness of the feet, cramps and spasms of the muscles ; whilst, in organs, softening of tissue, fatty degeneration, and other evidences of want of a proper supply of blood are observed. Spontaneous aneurisms rarely result from this change, the coats of the artery being more resisting than natural ; moreover, primary calcification is met with in the vessels below the axilla and knee, and spontaneous aneurisms beyond those points are amongst the curiosities of surgery. Thrombosis is occasionally met with, but is not common, as the endothelial lining is affected only in extreme cases and late in the disease. The lodgment of a small fibrinous embolus carried from atheromatous arteries above is an occasional occurrence, and is very likely to cause gangrene even when only one vessel is blocked, as the collateral arteries are no longer capable of enlarging to carry on the circulation. Occlusion of the calcified arteries by thrombosis or embolism is the common cause of the dry form of senile gangrene. The moist form arises from inflammation taking place in tissues, the vitality of which has been greatly lowered in consequence of the diminished supply of blood through the narrowed vessels.

Ossification of Arteries.—The formation of true bone in the coats of an artery is an extremely rare occurrence. A specimen of this kind was exhibited at the Pathological Society of London, by H. G. Howse, in 1877. The patient was a man aged 36, who was run over by a cart, the wheel passing over his shoulder. The axillary artery was ruptured, and death occurred as a result of the accident about a month afterwards. A small plate of cancellous bone was found in the injured vessel, apparently developed in the middle and outer coats. Its greatest thickness was about a quarter of an inch.

Effects of Diseases of the Arteries.—The various effects of diseases of the arteries have already been mentioned with the affections to which they are due, but it may lead to a clearer comprehension of the subject if they are again referred to, as the same effect may result from more than one cause. The most important effects of arterial disease are Ulceration of the Coats of the Artery ; Spontaneous Rupture ; Contraction or Occlusion of the Vessel, and, lastly, Dilatation into some of the various forms of Aneurism.

Ulceration of Arteries.—Loss of substance in the inner coat results from superficial fatty degeneration (p. 94), and from softening of an atheromatous patch (p. 88). Neither of these processes is a true ulceration. Genuine ulceration of the inner coat is in reality scarcely ever met with. When true ulceration of an artery takes place, it is the result of causes acting from without, attacking first the external coat, as in the case of a sloughing sore opening a main artery, or the pressure of a sequestrum in the popliteal space against the vessel.

Spontaneous Rupture of an artery is rare, and never happens without previous disease of its coats. Experiments made by Peacock, which I have repeated, and the accuracy of which I can fully confirm, prove that a healthy artery will sustain a very great pressure from water injected into it, without its walls giving way. But, if these have been softened or weakened by disease, they may be unable to resist even the ordinary impulse of the blood ; and if this be driven on by any unusually forcible action of the heart, as under the influence of sudden violent strain or exertion, they may give way. This occurrence would be much more frequent than it is in atheromatous and calcareous patches, were it not for the inflammatory consolidation of the external coat of the vessel supplying that resistance which has been lost by the softening or destruction of the internal and middle tunics. Hence this rupture is most frequent in those vessels the outer coat of which is thinnest, and in which, consequently, it can least supply the place of the others, as in the arteries of the brain and in the intrapericardial portion of the aorta. The liability to rupture of a diseased artery by the distensile force of the blood impelled into it, is increased by the existence of an obstacle to the free flow of the blood out of its terminal branches in consequence of a congested, infiltrated, or chronically thickened state of the organ or part supplied by it.

Contraction and Occlusion of arteries are by no means rare sequences of lesions of these vessels. Narrowing of an artery may take place in various ways ; the orifice of a branch leaving an atheromatous trunk is often narrowed by the formation of a ring-shaped thickening of the inner coat (p. 92), and the calibre is diminished in calcification of the middle coat (p. 95), syphilitic arteritis (Vol. I., p. 1126), and endarteritis proliferans (p. 93). Causes acting from without, as pressure, or contraction of chronic inflammatory or cicatricial tissue in the immediate neighbourhood of the artery lead to a narrowing of its lumen. In this way the axillary, the iliac, and even the aorta, have been occluded. Tiedemann records from various sources no fewer than eight cases in which the abdominal aorta was completely closed, in all of which so full and efficient a collateral circulation had been set up, that the vitality of the lower part of the body was perfectly maintained, and in most the morbid state was not suspected during life. Besides these cases, he states that there are on record twelve instances of great narrowing of the aorta, at that point where the ductus arteriosus is implanted into it in fœtal life. These would appear in some way connected with the closure of the duct ; as in every case the indentation was greatest on the convex part of the aorta, which had been drawn in towards the mouth of the duct.

The final obliteration of a diseased artery is most commonly the result of thrombosis. Thrombosis takes place in arteries under much the same conditions as in the veins. Whenever the normal endothelial lining of the vessel is lost or its "physiological integrity" impaired by degenerative changes, the blood tends to coagulate upon the diseased surface. The rapidity of the arterial flow, by preventing the adhesion of the white corpuscles, counteracts this tendency to a certain extent, but when the blood-stream becomes slackened either by great dilatation of a large trunk, or by narrowing of the orifice of a branch or feebleness of the heart's action, a deposit of fibrin very readily takes place. An artery of the second or third magnitude may thus be obliterated. When a thrombus has formed in a branch it may extend by fresh deposit into the main trunk, and form a mass of fibrin projecting into its lumen (Fig. 443). Thrombosis of the diseased artery is probably in a considerable number of cases the determining cause of dry gangrene in old people.

Complete obliteration of an artery is in many cases the result of embolism.

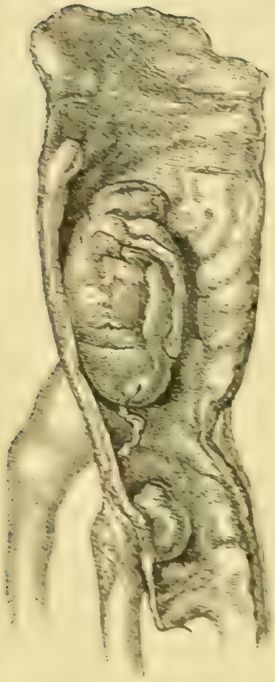

Fig. 443.—Thrombosis of two of the chief branches of the abdominal aorta; projection of the thrombus into the main trunk.

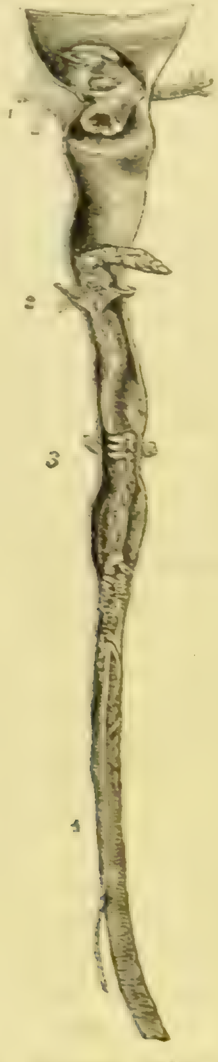

Fig. 444.—Embolism of the axillary artery with thrombosis of the brachial for some distance below the embolus. 1. Subclavian; 2. Axillary artery; 3. Subscapular and post-circumflex arteries; 4. Brachial.

The embolus is usually composed of a mass of fibrin which has been deposited on some diseased part of the larger vessels, and subsequently washed away by the blood-stream and lodged in some part at which the trunk suddenly narrows when bifurcating or giving off a large trunk. The source of the embolism may be the vegetations formed upon the valves of the heart in acute rheumatism or ulcerative endocarditis, the fibrin deposited in a pouch of a dilated aorta, or on a projecting calcareous plate, or a fragment of a clot projecting into the main trunk from a thrombosed branch, as in Fig. 443. The effects produced vary with the nature of the embolus and its size. When derived from the vegetations on the valves in ulcerative endocarditis it may give rise to inflammation and softening of the coat of the artery at the point at which it lodges (see Embolic arteritis, p. 86) ; more commonly it leads merely to obliteration of the artery by the ordinary processes already described. If it lodge in a small artery in a part in which the anastomosing circulation is free, it produces no effect beyond the permanent closure of the vessel ; if it lodge in a terminal artery, as in one of the abdominal viscera, it gives rise to the formation of a hæmorrhagic infarct (Vol. I., p. 983), followed by the subsequent degeneration and shrinking of the affected area. These old infarcts, forming wedged-shaped buff-coloured patches of considerable toughness, are commonly met with in the spleen and kidneys in cases of advanced atheroma or fusiform aneurism of the aorta. When the embolus is large and lodges in a main trunk, as in the popliteal at its bifurcation, or in the axillary, spontaneous gangrene may result. This is the most common source of gangrene in young people, and is probably the immediate cause of a certain proportion of cases of senile gangrene, the embolus in the latter case being derived from the diseased surface of an atheromatous aorta. The case from which the accompanying drawing (Fig. 444) was taken was that of a woman 56 years of age admitted for spontaneous gangrene of the left arm ; the embolus lodged in the axillary artery had caused gangrene of the limb. The figure illustrates also the thrombosis of the vessel below the part at which the embolus has lodged, which frequently aids in the production of gangrene.

Gradual narrowing of an artery, ending perhaps in complete obliteration, causes few or no symptoms when the area affected is limited in extent and the collateral circulation is sufficiently active to keep up the supply of blood to the parts beyond the obstruction. The gradual narrowing of a considerable extent of the main vessels of the limb, such as is seen frequently from calcareous degeneration of the tibial arteries, gives rise to more or less definite effects, such as cold feet, cramps, numbness, and weakness of the legs. Such symptoms are often the premonitory signs of gangrene (see Vol. I., p. 905), and are an indication that care must be taken to keep the parts warm by appropriate clothing and to avoid any injury. The symptoms of embolism of a large trunk have been described already (Vol. I., p. 907).

CHAPTER XLIII.

ANEURISM.

By **Aneurism** is meant a tumour, resulting from dilatation of the whole or a portion of the coats of an artery caused by the pressure of the contained blood, and communicating with the interior of the vessel.

Traumatic aneurisms have been already described (Vol. I., p. 462). Spontaneous aneurisms, arising from disease of the coats of the artery, are alone considered in the present chapter.

Causes.—The causes of aneurism are divisible into those that predispose to, and those that excite the disease. Aneurism is **Predisposed** to by any affection of the arterial coats that lessens the elastic resiliency of the vessel, and at the same time weakens its resisting power. When an artery has undergone any of the changes described in the last chapter by which the natural elasticity of the walls is diminished, it becomes less able to contract on its contents, and to recover during the diastole from the distension occurring during the systolic impulse, and thus either complete or partial dilatation of its cavity takes place. This loss of elasticity, which eventually results in the dilatation of the vessel, never occurs except as the result of previous disease of the coats. In the very numerous specimens of dilated arteries that I have examined, I have never found one that had not undergone fatty degeneration, or atheromatous softening. Calcification prevents rather than favours dilatation of the artery, by hardening the coats and converting them into rigid inelastic tubes ; but atheroma softens them, and causes yielding of that portion of the vessel affected by it. I have frequently observed that the whole of an artery might be healthy except at one part, where there was an atheromatous patch, and where the vessel was dilated ; or that the whole of its coats might be calcified, except at one spot, where softening had taken place, and where consequently they had yielded under the outward pressure of the contained blood.

As aneurism, therefore, may be looked upon as one of the sequences of chronic endarteritis, the predisposing causes of the one condition must necessarily be the same as those of the other. Hence we find that age, gout, and syphilis influence the occurrence of the aneurismal disease by laying its foundations in the development of atheroma.

Age exercises a powerful predisposing influence on the occurrence of aneurism. It is during the middle period of life that aneurisms are most frequently met with ; at that age, indeed, when the arteries have already commenced to lose their elasticity, in consequence of degenerative changes, whilst, at the same time, the heart has not lost any of its force, or the general muscular system its vigour. This disease is excessively rare before puberty, yet is occasionally met with at early periods of life : thus Syme mentions a case of popliteal aneurism in a boy of seven, Hodgson had a preparation of a carotid aneurism in a girl of ten, and Schmidt records a case of spontaneous aneurism of the radial artery in an infant eight weeks old. R. W. Parker, in a most valuable paper on aneurisms in young subjects read before the Medico-Chirurgical Society in 1883, states, that after a careful search in medical literature, he has found only fifteen cases of spontaneous aneurism recorded as occurring under the age of twenty, including a case of his own of inguinal aneurism in a boy aged twelve years and eight months. In eight of the fifteen cases there was disease of the valves of the heart, in five the state of the heart was not recorded, and in two only was it stated to be healthy.

A forcible, irregular, and occasionally greatly increased action of the heart is the immediate cause of the over-distension and dilatation of the vessels, and thus of the production of aneurism. Hence we find that this disease is especially apt to be induced in those individuals in whom the muscular system is called upon to make sudden, violent, and intermittent exertions; as, for instance, in men who habitually lead somewhat sedentary lives, but occasionally and suddenly change their habits, and indulge in sports, such as hunting, rowing, or a long day's shooting, which they might without risk have practised in early life, but which cannot be taken up with impunity at an age when the arteries, having become weakened, are unable to bear the same strain upon their coats as heretofore. I agree with Porter in thinking that continuous, steady, laborious employments do not predispose to aneurism, as this disease is seldom met with amongst those of the working class who labour hard and uninterruptedly; but it occurs rather in those who, after long periods of comparative inaction, are occasionally and suddenly called upon to make very violent muscular efforts, disproportioned to their strength, or, at all events, to their previous habits. It is in this way that soldiers, sailors, and members of the wealthier classes in society, are rendered peculiarly liable to aneurism. As violent muscular strain and exertion predispose to this disease, we should necessarily expect to meet with it more frequently among men than in women: and accordingly, Crisp finds that, of 551 cases of aneurism of all kinds, more than seven-eighths occurred in men. It is important, however, to observe that different kinds of aneurism occur with varying degrees of frequency in the *sexes:* thus, this affection is met with in the carotid artery about as often in women as in men, whilst the other external aneurisms occur in the proportion of thirteen cases in males to every one among females. It is remarkable, however, that in the dissecting aneurism the proportions are reversed; for every one case in men, two occur in women.

Climate exercises an important influence on the occurrence of aneurism, which is far more frequent in cold than in hot countries. It is not, however, the geographical position or the meteorological state of a country that exercises any direct influence over the occurrence of this disease. It is in reality the habits of the people that dispose to it, and that regulate its prevalence; and it is to the more energetic nature and the more active physical habits of the northern nations that we must look for an explanation of its greater prevalence amongst them, than in the more indolent inhabitants of the South. If we may judge of the prevalence of aneurism in a country by the number of published reports of cases, I should say that it is of more common occurrence in Great Britain and Ireland than elsewhere; indeed, Roux states that it is less frequent in France than in England. In America it is also of frequent occurrence, but in the East Indies it is comparatively rare.

All those **Constitutional Conditions** which predispose to or cause chronic endarteritis or atheroma necessarily act as predisposing causes of aneurism.

(See Causes of Atheroma, p. 89). Syphilis is commonly said to tend specially to the production of aneurism, but I am not aware that we are in possession of any definite facts proving this. The increased arterial tension accompanying the chronic interstitial nephritis and general arterio-capillary fibrosis of chronic gout undoubtedly acts as a powerful predisposing cause of aneurism. Phthisis is antagonistic to aneurism on account of the feebleness of the heart's action and the low arterial tension in that disease ; moreover, violent muscular exertion is seldom undertaken by those labouring under it.

Any **obstacle to the free flow of blood** through an organ or the capillaries of a part causes an elevation of the arterial tension, but this is not greater in the vessel leading to the part in which the obstruction is seated than in the arterial system generally. Thus it has been experimentally shown that if the femoral artery be tied the increased arterial tension resulting from the obstruction thus introduced into the circulation is the same in the artery immediately above the ligature and in the carotid. Chivers's theory that aneurisms of the abdominal arteries are frequently due to obstruction in the abdominal organs is probably devoid of foundation. Spontaneous aneurisms of the smaller arteries, as the radial, ulnar, or tibials, are believed in the great majority of cases to be due to the impaction of an embolus washed on from a diseased heart ; but in these cases the obstruction to the flow of blood plays but a secondary part in the process, the most important element being the softening of the coats of the vessel consequent upon the irritating nature of the material of which the embolus is composed. There is no reason to believe that a simple embolus ever causes aneurism (see p. 86).

The only **Exciting** or **Direct Occasioning Causes** of aneurism are blows, violent strains, and wounds of an artery. When an atheromatous artery is concussed by a *blow,* the lining membrane covering the softened patch may be ruptured, the atheroma being poured out into the interior of the vessel ; and the external coat, with perhaps a portion of the middle adherent to it, becoming thus exposed to the pressure of the contained blood before it has been fully consolidated by chronic inflammation and the formation of new fibroid tissue, the foundation of an aneurism may readily be laid. In very forcible muscular efforts, it is easy to understand how an already weakened portion of the vessel may become dilated by the increased pressure that is thrown upon its interior : occasionally even the vessel may be completely torn across by a violent strain. *Wounds* implicating arteries are common causes of those various forms of aneurism that have already been discussed in considering Injuries of Arteries (Vol. I., p. 471).

CLASSIFICATION.—Aneurism may be classified as follows :—

1. FUSIFORM.—True.
2. SACCULATED.—
    - *a.* True.
    - *b.* False.
        - *α.* Circumscribed.
        - *β.* Diffused.
3. DISSECTING.

1. **Fusiform** or **Tubular Aneurism**.—This is a præternatural dilatation of an artery, all the coats of which are equally expanded through the whole circumference of the vessel. It occurs most frequently in the aorta, and may, though rarely, be met with elsewhere. The fusiform aneurism is not a mere dilatation of the vessel, for there are elongation, thickening, and degeneration of its walls as well. The elongation of the artery in the fusiform aneurism is

as marked as its dilatation, and is always very considerable. Thus the arch of the aorta may be increased in length by some inches, with a considerable space between the origins of the innominate, the carotid, and the subclavian, at the same time that its walls are greatly thickened, nodulated, and rugged. Sometimes several tubular or fusiform aneurisms are met with in the same vessel, with healthy portions of the artery between them. From these dilatations, sacculated aneurisms not uncommonly spring.

On examining the structure of a fusiform aneurism, it will be found that it is composed of an expansion and outgrowth of the coats of the artery. The thickness of the wall is maintained by growth from the inner and outer coats, the middle coat being stretched and atrophied in proportion to the size of the aneurism. The inner coat presents the changes already described as resulting from endarteritis; it is stiff, rugged, and tuberculated from the formation of atheromatous patches, and frequently calcareous plates are scattered over its surface. The outer coat is thickened and composed of dense fibroid tissue. Microscopic examination shows that the middle coat is thinned in proportion to the degree of dilatation. If the aneurism is of any considerable size, gaps are found here and there in which the middle coat is wanting, the diseased inner coat coming into direct contact with the thickened outer coat. No coagula are found in the dilatation, but a few filamentary shreds of fibrin are occasionally seen attached to the inner wall. The arteries that are usually the seats of fusiform aneurism are the arch of the aorta (Fig. 445), the iliacs, the femorals and occasionally the axillaries. This particular form of aneurism occurs most generally in vessels in which the yellow elastic coat is largely developed, and hence is rarely met with in arteries smaller than the femoral ; it occurs, however, in the basilar artery of the brain.

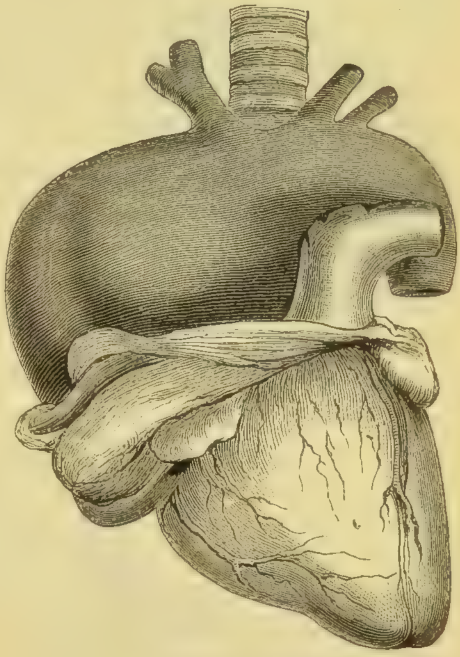

Fig. 445.—Large Fusiform Aneurism of Ascending Aorta bursting into Pericardium.

The fusiform dilatation, especially when seated in the arch of the aorta, may attain a very considerable magnitude, and may consequently exercise very injurious pressure on contiguous parts, thus producing great distress and danger to life. It is usually extremely chronic, increasing very slowly, and being compatible with existence for many years ; but it usually destroys the patient at last, and it may occasion death in several ways. Thus, if it be situated in the aorta, death may take place from syncope. This may be caused by the failure of the inelastic aorta to fill the coronary arteries during the diastole of the heart, or from imperfect supply of blood to the brain. Then, again, death may result from pressure on important parts, as on the bronchi or the œsophagus. When, however, a tubular aneurism of the arch of the aorta occupies the intrapericardial portion of the vessel, it not unfrequently happens that, owing to the absence of a sheath in this situation, the artery may rupture. It most commonly happens that a fusiform aneurism remains quiescent, being a source of discomfort, but not of death, until the sacculated form of the disease springs from its side; and then this, becoming the more formidable affection, may destroy life in some of the ways peculiar to it.

2. **Sacculated Aneurism.**—By a sacculated aneurism is meant a tumour springing from the side of an artery or of a tubular aneurism, with the interior of which it communicates by a narrow aperture, called the mouth of the sac (Fig. 447). It is generally divided into the *True* and *False* varieties.

True Sacculated Aneurism.—By this is meant a partial dilatation of all the coats of the vessel. The question of the existence of this form of aneurism has given rise to much discussion, and although it is of little practical importance, it is of some pathological interest. Scarpa doubted its occurrence, and Bizot coincided with him. With these eminent pathologists, however, I cannot agree: and though I am willing to admit that many of the so-called "true" aneurisms are not so in reality, yet I cannot doubt, from repeated observation, that Hodgson was right in saying that in their early stages sacculated aneurisms are not unfrequently of the true kind. Thus, we occasionally find, as Peacock pointed out, small digital pouches springing from the walls of some of the larger arteries, through the whole of which the external, middle, and internal coats can be demonstrated by maceration to exist; and in those aneurisms which are formed by the dilatation of a comparatively large portion of the arterial wall, it not unfrequently happens that the tumour remains of the true kind for some time, as I have ascertained by careful dissection. But after an aneurism has attained a certain size, its coats become so fused together, and so closely incorporated with the neighbouring tissues, that their precise structure cannot be made out. Indeed for a sacculated aneurism to be of the *rue* kind, I believe that two conditions are

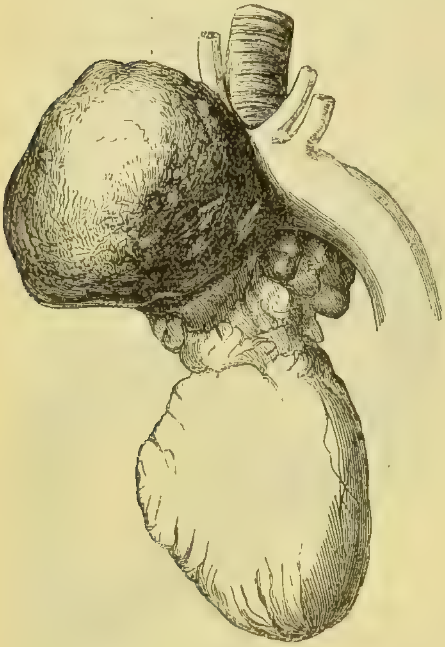

Fig. 446.—Sacculated Aneurism of Ascending Aorta. Death by Pressure.

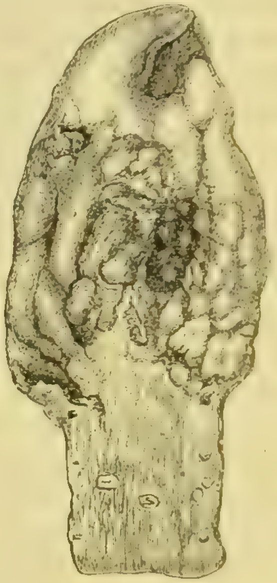

Fig. 447.—Upper part of Descending Aorta laid open, showing the mouth of the sac of an Aneurism. The inner coat round the opening is irregular from patches of atheroma and masses of fibrin.

necessary :—1, that the tumour itself be small ; and 2, that the mouth of the sac be of tolerably large dimensions. Porter says that he has never met with a *true* aneurism larger than a small orange ; and certainly none of those that I have seen, provided they were of the sacculated kind, have exceeded this size. In true sacculated aneurisms, also, it is necessary that the mouth of the sac, or that portion of it which communicates with the interior of the artery, should be of good size, and not bear too great a disproportion to the wall of the tumour. I cannot conceive a large sac with a small mouth to be a true aneurism. But in all cases of true aneurism, however small they may be, the size of the sac greatly exceeds that of its mouth. It is, therefore, clear that there must have been not only expansion, but a degree of hypertrophy and overgrowth of the wall of the vessel, just as in the tubular aneurism, otherwise the sac would be thinned in the direct ratio of its expansion. This overgrowth takes place chiefly from the outer coat, and, in a less degree, from the inner and not at all from the middle. When the sac is very small the expanded middle coat can be traced throughout it ; when somewhat larger, patches of the middle coat can be recognized with wide gaps between them ; but when it reaches any considerable size the greater part is composed of dense fibroid tissue in which none of the proper structure of the middle coat, nor in most cases of the inner, can be demonstrated.

False Sacculated Aneurism is that variety of the disease in which the internal, or the internal and middle, coats have been ruptured, and are consequently deficient. This is by far the most frequent form of sacculated aneurism, and is that which is met with of so great a size. In by far the majority of cases, the internal coat, and the innermost layers of the middle coat, have been destroyed by atheromatous degeneration, leaving an erosion or depression in the interior of the artery, with weakness of the corresponding portion of its wall, which becomes expanded by the outward pressure of the blood. In these cases the sac is formed principally by the outer coat, in which some remains of the middle may still be recognized. That the sac is formed by chronic inflammatory new growth in the external coat and not merely by expansion, is evident from its being thicker than the corresponding coat of a healthy artery. The thickness of the sac is increased when it reaches any considerable size by adhesion of neighbouring parts to it, which become fused into its structure as a consequence of the chronic inflammatory process set up round the aneurism from the pressure it exerts on the surrounding structures. The formation of an aneurism by the hernial protrusion of the internal and middle coats through an ulcerated aperture in the external coat has been described ; but, though there is a preparation in the Museum of the College of Surgeons that is supposed to illustrate this fact, I doubt the existence of such a form of the disease, and after careful examination think that the preparation in question represents rather an artificial dissection than a true rupture of this dense and resisting structure.

Surgeons generally recognize two varieties of false aneurism—the *circumscribed* and the *diffused.* By the *Circumscribed False Aneurism* is meant that form of the disease in which the blood is still contained within a sac, formed by at least one of the arterial coats, however expanded and altered in its structure this may be. The term *Diffused False Aneurism* includes two distinct varieties of the disease. In one there is rupture of the sac, with general and widely spread extravasation of blood into the areolar tissue of the limb or part. In the other it happens that the sac formed by the dilatation and hypertrophy of the outer coat of the artery is ruptured, and the blood, although diffused beyond this, is still confined in a sac of condensed areolar tissue, formed by that of the structures into which the blood has been effused, matted together with coagulum and inflammatory exudation.

The terms *True* and *False* are frequently used in a sense somewhat different to that above given, the former being applied to all those aneurisms which possess a distinct sac continuous with the coats of the artery and distinct from the surrounding tissues, and the latter to those in which the sac is formed, in part at least, from the condensed connective tissue of the structures in which the tumour is situated.

3. **Dissecting Aneurism** is a remarkable form of the disease, originally described by Shekelton, in which the sac is situated in the wall of the artery between its coats. It originates in consequence of the internal coat of the vessel becoming eroded, and giving way before any of that matting together of the tissues around the patch has taken place, which prevents the blood from being forced between the different tunics of the artery. The rupture, although originating in the internal coat, always extends between the layers of the middle one, splitting this up into two laminæ, and in some cases it also separates the middle from the external tunic of the vessel. On examining the artery in a case of dissecting aneurism, its coats will always be found to be easily separable from one another, and to be very lacerable, often appearing soft and sodden as if macerated. For the production of this disease, indeed, two conditions are necessary: 1. That there be atheromatous disease of the artery, destroying a portion of the internal and of the innermost layers of the middle coat; and 2. That there be also a general softening of the tissue of the middle coat, with want of cohesion between the different tunics of the artery: this, indeed, may be considered as the essential condition disposing to the formation of a dissecting aneurism, and causing the disease to assume this rather than the sacculated form.

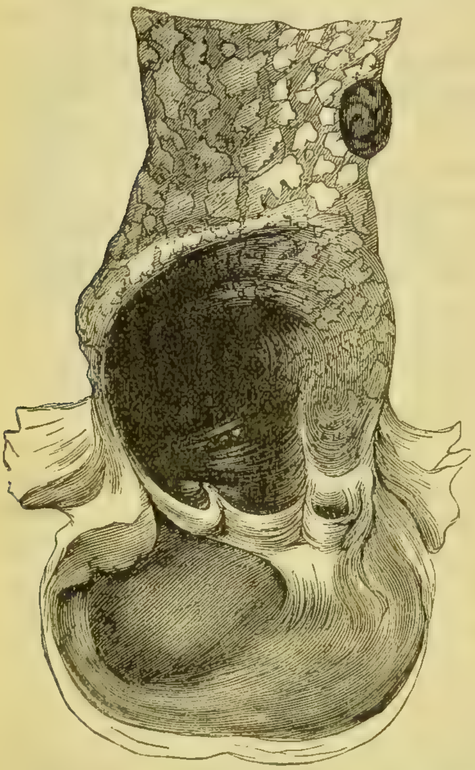

Fig. 448.—Rupture of Lining Membrane of Aorta, giving rise to a Dissecting Aneurism which burst into Pericardium. Aorta much dilated and covered with Calcareous Plates, except where the Aneurism occurred: there it was atheromatous.

In a dissecting aneurism the blood may often extend to a very considerable distance between the layers of the middle coat. Thus it may reach from the arch of the aorta to the iliacs, or from the same part to the bifurcation of the carotids. The disease occurs only in the aorta, and its principal branches—in those arteries, indeed, in which yellow elastic tissue is abundant in the middle coat.

Dissecting aneurisms arrange themselves into *three distinct classes.* 1. In one class, the blood, after having passed for a distance of several inches, or even more, through the substance of the middle coat, bursts through the external coat, and becomes effused into the areolar tissue outside the vessel and around the seat of rupture, or into the neighbouring cavities (Fig. 448). In these cases, which constitute the most common variety of the disease, death usually occurs rapidly, the patient feeling intense pain along the line of rupture, and falling into a state of syncope. 2. The external coat may resist the impulse of the blood, which consequently continues to pass between the layers of the middle coat until it meets a softened and atheromatous patch, and then again bursts into the canal of the artery. In this form of the disease, the patient may live for years after the occurrence of the rupture; the new channel that the blood has taken becoming lined with a dense smooth membrane, and resembling closely the interior of the artery, from which, however, it is separated by a kind of septum. The appearance here presented by the vessel has occasionally been erroneously described as constituting a double aorta. 3. The blood may find its way between the laminæ of the middle coat, but does not escape farther by rupture of the external, or by the giving way of the lining membrane of the vessel. A sac is consequently formed in the substance of the middle coat, which may become chronic, but which will at last rupture externally.

Process of Formation of an Aneurism.—The sequence of the changes leading to the formation of an aneurism is briefly as follows. The artery having been affected with chronic endarteritis, a patch of atheromatous softening forms, and the lining membrane covering it, perhaps with a portion of the inner layers of the middle coat, becomes eroded; or the walls of the vessel may be weakened at this point without any destruction of their coats. Cohesion, however, takes place between the tissues of the vessel at the eroded or weakened spot; and the outer coat becomes strengthened and thickened by the formation of dense fibroid tissue. Dilatation next takes place at this point; if of the entire coats, a *true* aneurism is formed; if of the eroded tunics, a *false* aneurism occurs: but if no cohesion have previously taken place between the different coats of the vessel, the blood becomes effused into and between them, thus constituting a *dissecting* aneurism.

Structure of a Sacculated Aneurism.—An aneurismal sac, if it be composed of a dilatation of the coats of an artery, may be recognized on dissection by the atheromatous and calcareous patches which are met with in the tissues of which it is composed. If it be a false aneurism, it will be found that there is little, if any, of these deposits in the walls of the sac. An aneurismal sac may vary in size, from a tumour not larger than a cherry to a growth of the magnitude of a cocoa-nut. The mouth, which is oval or round in shape, varies greatly in size, being always very small in proportion to the sac. Usually the interior of an aneurismal sac contains a quantity of colourless fibrin, arranged in concentric laminæ of but moderate thickness; these laminæ of fibrin are of a pale-buff colour, dry, and somewhat brittle where they are most closely applied to the wall of the sac; the more external were first deposited, and occasionally are found to have undergone a kind of fatty degeneration; as we approach the interior of the vessel, they become softer and more coloured, and at last, in the central portions, dark masses of coagulum are often met with.

This colourless laminated fibrin was termed by Broca the *active* clot, as it is deposited only when the blood is in motion in the sac of the aneurism. It is formed in the same way as a colourless thrombus in a diseased vein (see p. 54), the first step in the process being the adhesion of a layer of white corpuscles to the diseased surface of the aneurismal sac. These disintegrate, and thus determine the formation of a layer of fibrin. The microscopic examination of recent laminated clot shows the presence of numerous white corpuscles which have escaped disintegration between the layers of fibrin. It is thought by some physiologists that possibly these are of a different nature from those which take part in the process of coagulation. In the older layers of clot no corpuscles are recognizable, but much fatty and granular matter is always found, which may have resulted from their disintegration. The part played by the adhesion of the corpuscles in the formation of laminated fibrin explains the influence of retardation of the blood-stream on its formation. In fusiform aneurisms in which the flow of blood is rapid throughout the dilated vessel, adhesion takes place with difficulty, and no clot is usually formed, while in sacculated aneurisms in which the movement of the blood is necessarily much slower, laminated fibrin is always abundantly deposited. It will be afterwards seen that those modes of treatment by which the flow of blood through the sac is retarded, exert the most powerful influence in determining the deposit of layers of clot. The colour of the clot varies in different cases; the more rapid the flow of blood, the fewer red corpuscles will be entangled in the coagulum, the slower it is the darker the clot will be. Complete arrest of the circulation leads to the formation of an ordinary dark blood-clot, exactly like that produced when blood, withdrawn from the body, is allowed to coagulate. Clot of this kind is always found *post-mortem* in the middle of the sac of the aneurism, and is then formed probably immediately before or after death. Those modes of treatment which completely arrest the flow of blood into the sac cause the formation of a similar coagulum. It is the *passive* clot of Broca.

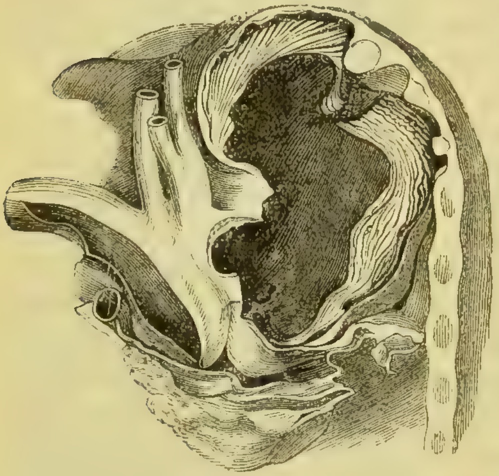

Fig. 449.—Large Aneurism of Ascending Aorta, projecting against (and protruding outwards) the ribs. Layers of Laminated Fibrin arranged in the direction of the Current of the Blood.

The layers of fibrin in the laminated clot are more or less concentrically arranged, but no single lamina reaches over the whole sac. The older layers bear evidence of having been formed when the cavity was smaller and subsequently flattened out against the enlarged walls of the sac (Fig. 449). The deposit of laminated fibrin exerts a powerful influence in preventing the too rapid increase of the tumour. The lining of the walls of the sac with such a tough and elastic material as the stratified fibrin, must greatly tend to deaden the force of the wave of blood that is projected against what would otherwise be an unprotected membrane. Another great purpose it serves is to lessen the capacity of the sac, and thus to diminish the pressure on surrounding parts, the distending force of the aneurism being proportional to the area of the sac as well as to the force with which the blood is driven into it. In those cases in which the laminated fibrin is small in quantity or altogether deficient, the aneurismal tumour rapidly increases with a forcible pulsation that is not met with in other circumstances. The dark coagulum or passive clot of Broca is a less efficient support to the wall of an aneurism than the colourless or active clot. It is much softer in consistence, and at first contains a considerable amount of serum; this gradually squeezes out as the clot contracts which thus becomes considerably diminished in bulk. If the clot completely fills the sac this contraction may possibly be followed by the re-establishment of a cavity, but the experience of some of the modern modes of treatment shows that it is not very likely to occur, the contraction of the clot being accompanied by a corresponding diminution in the size of the sac, chiefly due to the pressure of the surrounding structures. The clot further diminishes from the disintegration of the red corpuscles which form the chief part of its bulk. As this takes place it becomes decolorized, and thus, if the sac is only partly filled by a dark clot, this becomes flattened out and finally forms a layer indistinguishable from the laminæ of colourless fibrin.

Pressure-Effects.—As the sac of an aneurism enlarges, it exerts injurious and often fatal effects by its pressure upon contiguous parts. These pressure-effects deserve attentive study, as they constitute an important and, in some instances, the sole element in the diagnosis of aneurism. The pressure on the surrounding parts increases with the size of the sac. Dr. W. H. Stone thus describes the influence of increase in size on pressure: "The hydrostatic force rises rapidly as the sac enlarges; in fact in a modified geometrical ratio as against a simple arithmetical increase of the heart's impulse. We are thus from the first losing ground, and the malady is gaining on us according to some simple function of the fundamental law of equality of pressure in all directions. Haughton estimates the hæmostatic pressure of the blood in the human arteries as equal to a column of 9·923 feet. Taking the aneurism as of 3 inches in diameter, its internal surface will be 28·27 square inches, which gives a tension of 12·24 pounds. If the sac rises to 4 inches diameter, this increases to 50·26 inches of surface and to a tension of nearly 25 pounds."

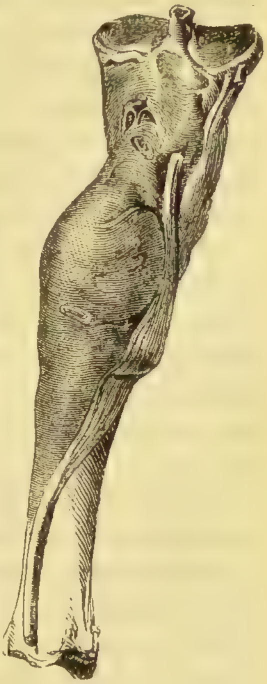

Fig. 450. — Flattening of Posterior Tibial Nerve by pressure of an Aneurism of the Calf.

One of the most common pressure-effects of aneurism is the occurrence of œdema of the limb or part, owing to the compression exercised by the tumour upon the large and deep *venous trunks* in its vicinity. The consequent obstruction to the venous circulation in the interior of the limb may give rise also to a distended or varicose condition of the subcutaneous vessels, and in some instances it may even go on to the production of gangrene. The pressure of the sac, also, on neighbouring *arteries*, or even on the upper part of the very vessel from which it springs, and its interference with the general capillary circulation of a part, are commonly associated with compression of the veins, and may considerably increase the ill-consequences resulting from it. The pressure upon a neighbouring artery may go on to perforation of the vessel by the sac, and so a communication between the two may be set up; thus aneurism of the aorta has been known to perforate and communicate with the pulmonary artery. By its pressure upon neighbouring *nerves*, an aneurismal sac may give rise either to great pain in the part supplied by them, or to disturbance of their function; the nerves themselves becoming, in some cases, expanded or flattened out, and ribbon-like (Fig. 450), and in other instances considerably elongated. The pain in the nerves is often one of the earliest signs of the existence of an aneurism. The pain is usually of two kinds: it is either lancinating and radiating along the course of the nerve that is compressed; or, when the tumour presses severely upon neighbouring parts and tissues, more especially if it give rise to erosion of the bones (as in Fig. 449), an aching, burning, tearing, or boring sensation is often experienced in the part subjected to the pressure. In other cases, again, important modifications in the function of parts take place, in consequence of the pressure that is exercised upon their nerves. Thus, for instance, the compression of the recurrent laryngeal nerve will occasion hoarseness of voice from paralysis of the adductor and difficulty of breathing, depending on spasm or paralysis of the abductors of the vocal cords. On the *bones* an aneurism may produce very important effects by its pressure, often deeply eroding the osseous tissue. If the bone be a flat one, as the sternum, the aneurism may perforate it by making as smooth and round a hole in it as if this had been worked by the trephine. *Glandular organs and their ducts* in the neighbourhood of aneurisms suffer the most injurious effects from the pressure of these tumours, their functions being arrested, and the passage of their secretions interfered with; so, also, by the pressure exercised on the *trachea* and *œsophagus*, respiration and deglutition may be seriously impeded.

Number.—Aneurisms, though usually single, are not very unfrequently multiple. There may be more than one tumour of the kind in the same limb; thus the iliac and femoral arteries on the same side may both be affected. In other cases, corresponding arteries in opposite limbs are the seat of aneurism; thus the two popliteals are not unfrequently found to be the seat of this disease, and occasionally an aneurism may exist in one of the limbs, and others in the arteries of the interior of the body. Numerous aneurismal tumours are at times met with in the same person; thus, Pelletan records a case in which no fewer than sixty-five were observed.

Duration.—The duration of an aneurism varies very greatly. In young full-blooded persons it often makes progress with great rapidity: whereas in elderly people of feeble constitution, in whom it is accompanied by more or less debility of the heart's action, the disease may assume a very chronic form; thus, Hodgson relates the case of an aneurism of the femoral artery of twenty years' duration. Much also will depend on the situation of the aneurism, the size of the mouth of the sac, and the relation of the sac to the impulse of the blood into it; the larger and more direct the mouth of the tumour, the more readily will the blood be projected into it at each impulse of the heart, and the more quickly will it expand.

Symptoms.—The symptoms of an aneurism are of two kinds: 1. Those that are peculiar to this disease; and 2. Those that are simply dependent on the presence of the tumour occasioned by the enlarging sac. The peculiar or pathognomonic signs are those that are dependent on the communication of the sac with the artery, and which are ascertained by the manual and auscultatory examination of the tumour; those that are dependent on the mere size of the growth are the pressure-effects. It is of course only in external aneurisms that those signs which are ascertainable on manual examination of the tumour can usually be recognized. In internal aneurisms, in the majority of cases, the auscultatory signs and the pressure-effects afford the best indications of the presence and nature of the tumour; though, when this approaches the surface, much information can be gained by palpation.

Symptoms of External Circumscribed Aneurism.—The tumour is usually round or oval, distinctly circumscribed, and situated upon and in close connection with some large artery. It is at first somewhat compressible, but afterwards becomes more and more solid as fibrin is deposited in it. The most marked sign is, perhaps, the *pulsation* that is felt in it from the very first. This is of a distensile, eccentric, and expanding character, separating the hands when laid upon each side of the tumour, by a distinct impulse from within outwards. The pulsation is most forcible in an aneurism in which there is but little laminated fibrin; and as this increases in quantity the pulsation gradually loses its tense expanding character, being converted into a dead *thud*, and in some cases ceasing entirely. When pulsation is obscure, the compression of the artery below the sac will cause it to become more distinct, or it may be increased in distinctness by elevating the limb or part affected. When the artery above the sac is compressed, the flow of blood into the tumour is necessarily arrested, and a considerable quantity of its more fluid contents may be squeezed out by gentle pressure. If the hands be then laid upon each side of the tumour, and the pressure be suddenly taken off the artery, the blood will be found to rush into and distend the sac by a sudden stroke, separating the hands from one another. This may be looked upon as one of the most characteristic signs of aneurism.

The *bruit* or *sound* emitted by the blood in its passage through an aneurismal sac was first noticed by Ambroise Paré. It varies much in character, being usually loud, rasping or sawing—loudest and roughest in tubular aneurisms. Occasionally the bruit is double, and if so, it clearly indicates the sacculated nature of the aneurism. It is possible, however, that when great aortic regurgitation is present, the backward current of blood in the large vessels might give rise to a feeble diastolic murmur in a fusiform aneurism. In many cases it is altogether absent; this especially happens in sacculated aneurisms with small mouths, or in those that are much distended with coagula and blood. The absence of sound, therefore, in a tumour must not be taken as a proof that it is not an aneurism. The sound is usually best heard in aneurisms that are not too fully distended with blood; indeed, it is usually most distinct when the sac is partially emptied. Thus, for instance, it not unfrequently happens that, in an aneurism of the ham or thigh no bruit, or but a very faint one, is audible so long as the patient is standing; but if he lie down, and elevate the limb so as partly to empty the sac, then it may be distinctly heard. Another sign of considerable importance consists in the *diminution in the size* of the tumour, and the *cessation of the pulsation and bruit* on *compressing the vessel* leading to the sac, and the immediate and sudden return of these signs on removing the pressure from the artery.

Many of the symptoms that have just been described are peculiar to and their combination is characteristic of aneurism, being dependent on the communication that exists between the artery and the sac. Those that result from the pressure of the sac upon neighbouring parts are common to aneurism and to any other kind of tumour; but, though not of so special a character as those that have just been described, they are of considerable importance in determining the nature of the disease when taken in conjunction with the other symptoms.

Symptoms of Diffused Aneurism.—When a sacculated circumscribed aneurism becomes diffused, the sac having given way, but the blood being still bounded by the tissues of the limb, the patient experiences a sudden and acute pain in the part, and usually becomes pale, cold, and faint. On examination, it will be found that the tumour has suddenly and greatly increased in size, at the same time that it has lost its circumscribed and distinct outline. The pulsation and bruit become materially diminished in force and in distinctness, having receded as it were from the surface, and may disappear altogether. The limb may also become œdematous, or may suffer in other ways from the diffused effects of the pressure of the aneurismal swelling upon the neighbouring veins and tissues. At the same time, the circulation in it being greatly obstructed, the limb may become cold and livid, and a sensation of weight and general inutility will be experienced in it. In these circumstances the aneurismal swelling usually becomes harder, in consequence of the coagulation of the blood in the areolar tissue around the sac; by which indeed the further extension of the disease is arrested, and a fresh boundary is often formed, so as to limit the extravasated blood. If it be left to itself, the tumour will now usually increase rapidly in size, sometimes without, sometimes with much pulsation, so that at last it may so obstruct the circulation through the limb as to occasion gangrene. The tension caused by the rapid increase of the tumour excites more or less acute inflammation in the surrounding structures. As it advances towards the surface, the skin covering it becomes thinned and reddened, the tumour becomes soft and semi-fluctuating owing to the coagulum breaking down, and eventually external rupture will ensue.

In some cases it happens that, when rupture of the sac takes place, the effused blood, instead of being limited by the surrounding areolar tissue, becomes suddenly and widely extravasated into the substance of the limb. When this untoward accident happens, the shock and local disturbance are very great, and the patient is suddenly seized with very severe lancinating and numbing pain in the part. The pain is most severe in those cases in which the rupture takes place under the deep fasciæ, by which the effused blood is tightly bound down; and it may be so intense as to occasion syncope. In other instances, faintness occurs from the sudden escape of blood from the current of the circulation into the substance of the part, being most marked in those cases in which the blood is suddenly and largely effused into the areolar tissue. If the extravasation happen in a limb, this will become greatly swollen, hard, brawny, and cold. The superficial veins are congested, and the circulation in the lower parts of the member is soon completely arrested by the pressure of the extravasated and semi-coagulated blood upon its vessels, more particularly the large venous trunks. In consequence of this, gangrene of a moist kind usually makes its appearance, and speedily destroys the patient's life.

Diagnosis.—The diagnosis of aneurism may in many cases be effected with the greatest possible ease by a student in surgery; in other instances it requires a vast amount of care, and the most experienced judgment, to come to a correct conclusion as to the nature of the tumour. This is easily done when the aneurism is superficial, recent, and circumscribed, the blood in it being fluid, and all the signs of the disease well marked. The diagnosis is often extremely difficult when the aneurism is deeply seated, or, if external, when it is old and filled with coagula ; also, if acute inflammation or suppuration have taken place about it, or if it have become diffused.

In making the diagnosis of aneurism we have, in the first place, to ascertain the existence or absence of a tumour ; and, after this has been done, to decide whether it be aneurismal or of some other character. Both points, the latter especially, are difficult to determine in internal aneurisms ; in the external the doubt is not as to the presence of a tumour, but as to its nature. The *tumours* with which aneurisms may be confounded may conveniently be divided into two classes—those that do and those that do not pulsate.

Every pulsating tumour is not an aneurism.—Thus there may be pulsation in various kinds of *encephaloid tumour* or *soft sarcoma*, or in *growths composed of nævoid tissue.* In such cases as these, many of the signs of aneurism are present ; thus the size of the tumour may be diminished by compression, and the distinct influx of blood into it may be felt on the removal of the pressure, the tumour returning to its original size with a soft swelling pulsation : there may also be a bruit, often of a loud and distinct character. But these tumours may generally be distinguished from aneurisms by their not being quite so distinctly circumscribed—and being soft, spongy, and elastic, without the sensation of fluid that is met with in some forms of aneurism, or of solid coagula that occurs in others. Again, the bruit is either soft, blowing, and more prolonged, or else sharp and superficial ; the pulsation, also, is not so distinct, and is more of the nature of a general swelling and heaving of the tumour than of a distinct thump. Much light is occasionally thrown upon these affections by their being met with in situations where aneurism cannot occur owing to the absence of any arteries of sufficient size to give rise to it, as, for instance, on the head of the tibia or the side of the pelvis ; but if a tumour of this kind be situated upon or under a large artery in the usual site of aneurism, then the diagnosis is certainly replete with difficulty, and cannot indeed in many cases be made. Several instances have occurred, in which Surgeons of the greatest skill and experience (as Guthrie and Stanley) have ligatured arteries on the supposition that they had to do with aneurism, when in reality it was one of the pulsating tumours just mentioned that closely simulated it.

Pulsation may be communicated to a *tumour of a fluid character* seated upon an artery ; here the diagnosis, though often difficult, is more readily made than in the last case. Attention to the history of the case, to the impossibility of diminishing the tumour by pressure either directly upon it or on the artery leading to it, its fluctuation, and want of circumscription, will usually point out its nature. Especial attention should likewise be paid to the facts that the pulsation is a distinct heaving up and down of the tumour, and neither eccentric nor distensile, and that the swelling may often be wholly or partly separated, by raising it up, from the artery lying beneath it. By attention to these points, abscesses in the axilla, under the pectorals, at the root of the neck, and in other situations where pulsation may readily be communicated to the fluid mass, can be distinguished from aneurisms ; yet errors in diagnosis have happened, and will continue to do so, from the intrinsic difficulty of these cases, and from no want of skill or care on the part of the Surgeon : and those will be most charitable in their criticisms of the mistakes of others, who have most frequently had occasion to experience these difficulties in their own practice.

Tumours that do not pulsate, either by their own vessels or by those that lie beneath them, are not so readily confounded with aneurism as the class of affections that has just been described. Yet it must be borne in mind that in some instances even aneurisms do not pulsate, or do so but very indistinctly, having become filled with a dense and firm coagulum. The non-pulsating tumours that chiefly require attention are *glandular swellings,* seated over the carotid artery at the root of the neck, or in the popliteal space. In the neck some thyroid tumours may also closely resemble aneurisms. If these be of a fluid character, their fluctuation, unvarying size, and the want of pulsation in them, sufficiently indicate that they are not connected with the artery, from which they may also frequently be separated, and upon which they may be distinctly moved. If solid, they are usually irregular and nodulated on the surface, and can frequently be detached by the fingers being passed underneath them and raising them from the subjacent vessel. There is much danger of mistaking a consolidated aneurism which is undergoing or has undergone spontaneous cure, and in which there is consequently no pulsation, for a solid tumour of some kind. I have known one instance in which the thigh was amputated for a very painful solid tumour of the popliteal space, which proved on dissection to be a consolidated aneurism pressing upon the posterior tibial nerve (Fig. 451).

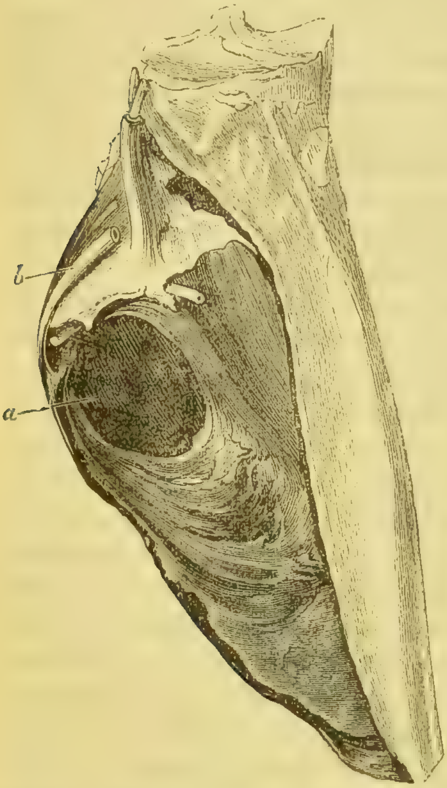

Fig. 451.—Section of Aneurism of Calf, undergoing spontaneous cure, mistaken for Tumour. Limb amputated. (*a*) Black recent Coagulum lying in centre of Laminated Fibrin. (*b*) Posterior Tibial Nerve stretched.

Aneurisms, more particularly those that are diffused, have not unfrequently been mistaken for *abscesses ;* and it is no very uncommon thing for a Surgeon to be called to an aneurism which, under this supposition, has been diligently poulticed, or painted with iodine. I have twice ligatured the external iliac for aneurisms of the groin that had been mistaken for abscesses. Occasionally, the more fatal error has been committed of puncturing the tumour with the view of letting out pus, when none appeared, and, either immediately or after a lapse of a few hours, profuse arterial hæmorrhage ensued. That this accident may arise from the intrinsic difficulties of the diagnosis, is evident from the fact that it has happened to such Surgeons as Desault, Pelletan, Dupuytren, Pirogoff, and many others. I have once seen this accident occur to a Surgeon of considerable experience, who, mistaking a diffused popliteal aneurism for an abscess, opened it with a bistoury, but finding no pus, applied a poultice ;

alarming hæmorrhage ensued in about forty hours, and I amputated the thigh on the second day after this untoward occurrence.

The difficulty in diagnosis is especially apt to occur in those aneurisms which, having become diffused, have ceased to pulsate, have no bruit, are elastic, softened, and diffluent to the feel, and in which the skin has become reddened and inflamed by pressure from within. It is only by careful attention to the history of the case, and by skilful manipulation, that the true nature of the tumour can be made out. But an aneurism may actually become associated with an abscess in one or two ways. Thus it may suppurate, the inflammation taking place in the areolar tissue around it, with swelling, redness, œdema, and heat of the integumental structures, increase of size in the tumour, and probably solidification of it. If this abscess be opened or allowed to burst, dark grumous pus will escape, followed by coagula and masses of broken-down decolorized fibrin, and sometimes accompanied, but more usually followed after a lapse of some hours, by a free and perhaps fatal discharge of florid blood.

Another form of combination between abscesses and aneurism consists in the opening of an artery by ulceration into the cavity of an abscess, so that the blood is projected directly into this from the opened vessel. In cases of this kind—of which the instance that occurred to Liston is a good example—we have the ordinary signs of abscess, usually of a chronic character, to which those of an aneurism are generally superadded suddenly, with great increase in the bulk of the tumour. This accident has been observed chiefly in abscess of the neck, opening up a communication with the carotid artery.

With **rheumatism** and **neuralgia** it would at first appear to be difficult to confound an aneurism, but in practice it is not so. I have known several cases in which the lancinating pains of aneurism, more especially when the tumour was internal, have been mistaken and treated for rheumatic or neuralgic affections; and I have even known the pain occasioned by the presence of a large aneurism of the thigh treated for several weeks as rheumatism. In a large proportion of popliteal aneurisms the patient first presents himself for rheumatic pains in the knee; in fact so frequently is this the case that it is a good rule whenever a patient complains of obscure pain in that joint, to examine the ham for an aneurism as the first step in making a diagnosis. In such cases as these, it is of course obvious that a little care and proper examination will usually serve to enable the Surgeon to avoid an error. The aneurismal may be distinguished from the rheumatic pain by its having a twofold character—being both lancinating and intermittent, as well as continuous, aching, and burning. When this kind of pain is persistent, especially about the back, the side of the head and neck, or arm, it ought always to cause the Surgeon's attention to be directed to the condition of the neighbouring large vessels.

TERMINATIONS.—**Spontaneous Cure** of an aneurism is of very rare occurrence. The manner in which it happens has been ably studied by Hodgson, and more recently by Bellingham; and the pathology of this process is of considerable interest, from its bearing upon the cure of the disease by surgical operation. The spontaneous cure may accidentally, though very rarely, occur by inflammation of the aneurism and consequent obliteration of the artery (see Suppuration of Sac); but most frequently it is by the gradual deposition of laminated fibrin in the interior of the sac that it is filled up completely. This process usually takes place in aneurisms affecting arteries of the second or third magnitude, rarely in those of the aorta, though both Hodgson and Broca have met with instances; and it can happen only in sacculated aneurisms, the fusiform not admitting of it, it being necessary that the blood flowing through the sac be somewhat retarded in its passage, so as to favour the adhesion of the colourless corpuscles which is the first step in deposit of fibrin upon the interior of the tumour. This process, which is the same as in the formation of a white thrombus in a vein (see p. 54), is the increase of a natural condition always going on in the sac. In all cases of sacculated aneurism, there is a tendency to the production of a spontaneous cure, though this is rarely accomplished. The tendency to it is shown by a contraction and partial occlusion of the artery *below* the sac, and the consequently diminished force of the circulation through it, by which the deposition of fibrin is greatly increased, at the same time that the collateral vessels given off *above* the sac often enlarge to a considerable extent, and thus divert from it blood which would otherwise have passed through it. This condition of the vessel below the sac may be looked upon as the first and most important step towards the consolidation of the tumour. The process is also materially assisted by the mouth of the sac being small, and so situated that the blood cannot be directly driven into it.

For spontaneous cure to take place, it is by no means necessary that the whole current of blood should be suddenly arrested. If such an accident occur, the aneurismal sac becomes filled with a large dark soft clot, which may yield, if from any cause a pulsating stream of blood be again admitted, but which under favourable circumstances may lead to a complete cure. If blood continue to circulate through the sac, deposit of laminated fibrin will take place if the impetus with which this fluid is sent into the tumour be considerably diminished. This may happen from the occurrence, in the distal portion of the artery or the mouth of the sac, of some one or other of those conditions that have already been described. So, also, it has been found that in those cases in which two aneurisms are situated upon one artery, the distal one is very apt to undergo partial or even complete consolidation, the blood losing its impetus in its passage through the first sac. Any constitutional cause or condition also, by which the impulse of the heart is lessened, and the force of the flow of blood through the sac diminished (as the occurrence of phthisis), will greatly favour the deposit of laminated fibrin and the consolidation of the tumour.

As the aneurism undergoes spontaneous cure, the pulsation in it gradually becomes more and more feeble, until it ceases entirely; the bruit proportionately lessens, the tumour becomes harder, and at last completely consolidated; at the same time, the anastomosing circulation is sometimes found to be established in some of the collateral vessels of the limb. Eventually, the solidified tumour shrinks in size, undergoing gradual absorption, with ultimate conversion into a small mass of fibroid tissue.

Suppuration with sloughing of an aneurismal sac is not of very frequent occurrence, but is especially apt to happen in those cases in which the tumour has increased rapidly, or has suddenly become diffused, and thus is exerting great pressure and causing severe tension of the surrounding parts. The accident is not uncommon also after operations undertaken for the cure of aneurism in which the wound comes in close proximity to the sac. The inflammation is then merely an extension from that in the wound, and is usually dependent upon septic contamination. Though the process is usually spoken of as suppuration of the sac, the inflammation commences in the tissues surrounding the aneurism, the sloughing of the sac itself being a secondary process dependent upon its nutrition being cut off by the pus that forms around it. Suppuration is particularly liable to happen around tumours of a large size that have become partly diffused, that are filled with masses of decolorized fibrin, and that are situated in places where the areolar tissue is abundant and lax, as in the axilla. The symptoms of this condition impending are swelling, tension with heat, throbbing, and redness of the parts around the tumour ; the integuments covering it pit on pressure, and are evidently deeply inflamed, at the same time that there is a good deal of fever and general constitutional disturbance. As the suppuration advances, the ordinary signs of acute abscess occur : the skin covering the tumour becomes red and livid at one part, where pointing takes place ; and if the Surgeon make an incision into it, or if the tumour burst (as assuredly it will if left to itself), a quantity of pus mixed with large masses of broken-down coagula will be let out. The discharge of the contents of the aneurismal sac may be followed by a fatal gush of arterial blood. Occasionally, however, as a consequence of the inflammation of the surrounding tissues, the artery becomes firmly plugged by a thrombus above and below the opening into the aneurism before the sac gives way, and thus hæmorrhage may be prevented and a spontaneous cure result, the cavity closing like an ordinary abscess after the sloughs and the broken-down clots have been discharged.

Causes of Death from Aneurism.—An aneurism may prove fatal in various ways. It does so when internal, most frequently by *pressure* on parts of importance in its vicinity, the patient being destroyed by the exhaustion induced by interference with their functions ; this is usually the way in which aneurisms of the aorta occasion death. In other cases the sac bursts into the pericardium, pleura, or peritoneum, and sudden death may occur from loss of blood ; or asphyxia may result from its giving way into the trachea. Then, again, death may result by the occurrence of *syncope,* more especially if the aneurism be of large size, and situated near the root of the aorta. *Embolism* of the cerebral arteries may occur in consequence of the detachment of a clot. External aneurism most commonly proves fatal by *rupture of the sac ;* this may either take place into the interior of a limb, giving rise to one or other of the diffused forms of aneurism, and terminate fatally by the induction of syncope or gangrene ; or an aneurism may kill by rupture occurring externally, on one of the surfaces of the body.

The rupture of an aneurism is not always immediately fatal, the aperture in the sac being plugged up by a mass of coagulum, as happened in the case represented in Fig. 452 ; on the gradual detachment of the deeper portions of this coagulum the bleeding may recur in small quantities at intervals, and more or less speedily carry off the patient. On the mucous surfaces, as of the œsophagus or trachea, rupture occurs in a similar manner (Fig. 452). On the serous surfaces, as into the pleura or pericardium, the aneurism may burst by a fissure or by a stellate opening (Fig. 453) forming in the membrane. An aneurism has been known to give way and discharge blood for some weeks before it proved fatal ; and it may even happen that, after the rupture has occurred, no hæmorrhage may take place, but death may result from the pressure of the tumour. Thus, in the case of Liston, the sac of the aneurism which caused the death of that great Surgeon had actually given way, a mass of coagulum projecting from it into the trachea; yet death resulted from the irritation induced by pressure upon the inferior laryngeal nerve, and not from hæmorrhage.

Treatment.—The treatment of aneurism is of two kinds—constitutional and local. In many cases, as in the various forms of internal aneurism, for instance, the constitutional treatment can alone be employed; and in all cases of external aneurism it should be had recourse to as an important adjunct to any local measures that are adopted.

In the **Constitutional or Medical Treatment** of aneurism, the great object is to bring about the same condition as that by which the spontaneous cure of the disease is effected, and, indeed, to put the patient and the part in the most favourable state for nature to consolidate the tumour; and, though it may not be possible in the great majority of cases to effect a cure in this way, at all events the disease may be palliated, and its progress retarded. The sacculated is, however, the only form of aneurism that can ever be cured by constitutional means; in the fusiform variety, all that can be done is to retard the progress of the disease.

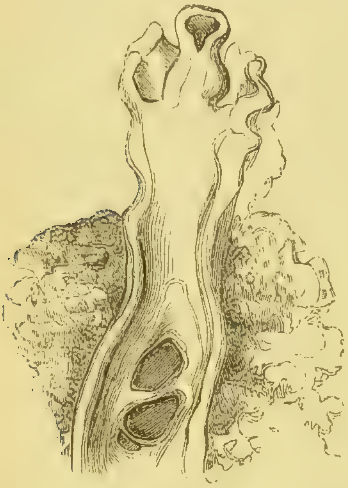

Fig. 452.—Aperture in Œsophagus produced by Pressure of an Aortic Aneurism.

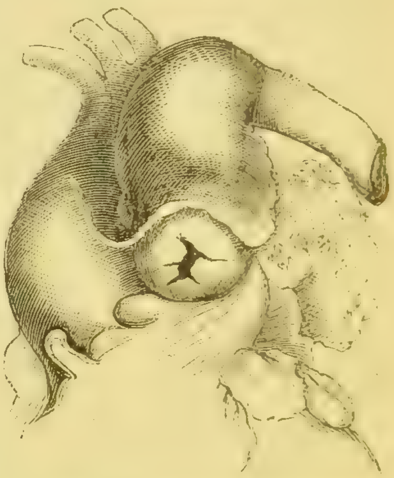

Fig. 453.—Stellate Rupture of an Aortic Aneurism into Pericardium.

The principal objects to be kept in view are, in the first place, to lessen the force of the heart's impulse, so as to diminish the eccentric pressure upon the arterial coats; and, secondly, so to modify the condition of the blood as to dispose it to the deposition of its fibrin. In carrying out these indications, it should be borne in mind that there are two opposite conditions of the system in which aneurism occurs: in one there is a plethoric, and in the other an anæmic tendency. The plethoric and irritable state of system occurs chiefly in young subjects, in whom the progress of the disease is acute and rapid, attended by much impulse and excitability of the heart, and throbbing of the arteries generally. The other condition of the system is found usually in elderly people, in whom there are a feeble pulse, a quiet heart, a cachectic state of health, and a tendency to anæmia; in such a habit of body the disease makes slow progress. In these opposite conditions it is perfectly clear that the same plan of treatment cannot succeed; and that the constitutional means must accordingly be modified according to the state in which the patient is.

In the *acute or hyperæmic state*, the plan of treatment originally introduced by Valsalva, and hence called by his name, by which plethora is removed, the irritability of the heart and the force of its action lessened, and the blood brought into a healthy condition, may be advantageously employed, in the modified manner that has been recommended and adopted by some modern Surgeons. Pelletan, Hodgson, and Tufnell especially report very favourably of this treatment, and I have seen several instances in which it has proved decidedly beneficial. As recommended by Valsalva, this method of treatment was intended to carry out two important points: 1, by a process of gradual starvation and depletion to reduce the quantity of blood in the system, the force of the heart's action, and consequently the pressure exercised upon the walls of the aneurism; and, 2, after the patient had in this way been reduced, the plasticity of the blood was to be improved by feeding him up in a gradual and careful manner, so that the tendency to the deposit of laminated fibrin might be increased. Valsalva endeavoured to carry out the first of these objects by subjecting the patient to small and repeated bleedings, and by gradually reducing the quantity of food that was daily taken, until it was lowered to half a pound of pudding in the morning, and a quarter of a pound in the evening. In this way the patient's strength was reduced until he could scarcely be raised up in bed without fainting; the quantity of food was then gradually augmented, so that the plasticity of the blood might be restored. It is seldom that Surgeons carry out Valsalva's plan of treatment in the precise manner indicated by him; it is generally found to be more convenient to modify it somewhat according to the circumstances of the case, though the principles on which it is conducted are essentially the same.

In adopting any constitutional treatment in cases of aneurism, the first and most essential point to be attended to is to keep the patient perfectly quiet in bed and free from all mental, emotional, or conversational excitement. The diet should at the same time be very carefully regulated, being gradually reduced in quantity, and being made to consist principally of farinaceous food, with a very small quantity of meat, but little liquid, and a total absence of stimulants. Perhaps the best regimen is that recommended by Bellingham, consisting of two ounces of bread and butter for breakfast, two ounces of bread and the same quantity of meat for dinner, and two ounces of bread for supper, with about two ounces of milk or water with each meal, or occasionally sipped in small quantities. At the same time purgatives should be administered, especially such as give rise to watery stools, and remove obstructions of the portal system; with this view a scruple of the compound jalap powder may be given twice a week. In some cases, if the heart's action be particularly strong, recourse may advantageously be had to small bleedings from time to time.

Iodide of potassium, in doses varying from five to thirty grains three times a day, has been largely used in cases of intrathoracic and abdominal aneurism, especially by Chuckerbutty, G. W. Balfour, and W. Roberts, and its good effects lend some weight to the supposed syphilitic origin of many aneurisms. In a large proportion of the cases thus treated, the sufferings of the patients have been relieved; there has been diminution of the size of the sac, and in several instances the cure has been apparently perfect. The enforcement of the recumbent posture is, as Balfour rightly insists, of high importance as an adjuvant in this treatment. There certainly appears to be sufficient evidence to warrant a trial of the iodide in the constitutional treatment of aneurism.

By judiciously carrying out these plans of treatment and modifying them according to the circumstances of the case, consolidation of the aneurismal tumour may occasionally be produced ; or, if this be not obtained, the progress of the disease will be very materially retarded.

When aneurism occurs in *old, feeble, cachectic, or anæmic persons*, a lowering plan of treatment is altogether inadmissible : here, such a course must be adopted, as will improve the plasticity of the blood, and regulate the action of the heart. With this view, complete rest, the administration of the preparations of iron, a dry but nourishing meat diet, and the occasional employment of opiates to relieve pain and to quiet the system, will be attended by the best results. In aneurism occurring in elderly people and amongst the poorer classes, this plan is perhaps more successful than any other.

In the **Local Treatment** of aneurism but little can be done with the view of checking its progress, except by the employment of direct surgical means. The application of ice to the surface of the tumour is said to have acted beneficially in some cases ; but it is a painful remedy, and may occasionally be attended by sloughing of the skin to which it is applied. When the pain attending the increase of the tumour is considerable, much relief may be obtained from the hypodermic injection of morphia, the application of belladonna plasters, or the use of an embrocation composed of equal parts of oil and of the strong tincture of aconite. These means comprise the only local measures that can be adopted in those cases of internal aneurism which are beyond the reach of surgical interference.

SURGICAL TREATMENT OF ANEURISM.

In all those cases in which it is possible to delay with safety, no surgical proceeding should be undertaken for the cure of aneurism until the patient has been subjected to proper constitutional treatment for some time ; the success of the more direct surgical means depending greatly, in the hyperæmic forms of aneurism, on the heart's impulse being lessened, and on the blood being brought into as healthy a state as possible ; whilst, in the anæmic form of the disease, an increase in the plasticity of the blood is essential for the cure of the case ; for, as the occlusion and consolidation of the sac, after surgical procedure, depend on the same conditions being induced that are successful after medical treatment, the same constitutional means should be adopted in one case as in the other. Before proceeding to the employment of any direct surgical means for the cure of an external aneurism, it is necessary to ascertain that there is no internal aneurism present, and that the heart is free from disease. From want of this precaution, it has happened that patients have died on the operating table at the moment when the artery was being ligatured, or that they have expired shortly afterwards, from the disturbance of circulation consequent upon the necessary surgical procedures.

There is not a more interesting chapter in the history of Operative Surgery than that which records the changes that have taken place and the progress that has been made in the treatment of aneurism.

The older Surgeons were either afraid to meddle at all with aneurism, and amputated the limb affected by it, or tried to restrain the progress of the disease by tight bandaging and direct pressure upon the tumour, or had recourse to the troublesome, difficult, and dangerous operation of laying open the sac and ligaturing or applying the actual cautery or styptics to the diseased artery on each side of the opening in it. In 1785, John Hunter substituted for these dangerous methods of treatment, the simpler and more scientific procedure of ligaturing the artery in a distant part of its course, above the sac, and thus directly cutting off the influx of blood into the tumour. This undoubtedly constituted one of the greatest and most direct advances in Surgery that has ever been made by the single act of one man, and the "Hunterian Operation" continued for more than half a century as almost the sole method of treating this formidable disease, when it affected an artery to which the operation was applicable. It was not until 1841—42 that the Dublin Surgeons, distinguished as they ever have been by their practical skill as much as by their scientific devotion to their art, inaugurated a new era in the treatment of this disease. For they found in practice, and they demonstrated by an elaborate pathological investigation, as convincing as it was exhaustive, that the coagulation of the blood by which an aneurismal sac is occluded, may as readily take place when the current of blood from the artery into the sac is interrupted by compression, as when it is arrested by tying the vessel. And they established this great fact, that wherever the artery could be reached so as to admit of the application of an instrument for compression between the aneurism and the heart, the ligature of the vessel was no longer the only hope of cure.

But the treatment of aneurism was still farther simplified, when Vanzetti showed that the simple pressure of the finger on the feeding artery is sufficient in many cases to bring about the cure of the aneurism by the formation of a coagulum within it. And in addition to this, the fact was established, that in some cases adequate compression of the vessel and sac might be effected by simple flexion of the limb. Thus, then, we have had a progressive simplification in the treatment of aneurism, as it has been proved that instrumental compression may be substituted for the ligature, that pressure with the finger or flexion of the limb suffices for the deposition of that coagulum on which the cure of the disease depends; and, still more recently, the sphere of the applicability of compression has been greatly extended by conducting it during prolonged anæsthesia.

We will now proceed to consider in detail these various methods of treatment. They are as follows: 1. Ligature above and below the aneurism after laying open the sac; 2. Ligature of the artery on the cardiac side; 3. Ligature of the artery on the distal side; 4. Compression by instruments; 5. Digital compression; 6. Compression by the elastic tourniquet; 7. Flexion of the limb; 8. Acupressure; 9. Manipulation; 10. Galvano-puncture; 11. Injection of the sac with coagulating fluids.

All these various methods of treatment, however they may differ in their details, have, with the exception of the first, the same great principle in view, viz.: the consolidation of the aneurismal tumour by the deposit of coagulum within it. When the process adopted is of such a nature as to lead to the slow deposit of coagulum, this will be found to be pale, firm and laminated, the *active* clot of Broca. When the deposit is rapid, it will be dark, soft and homogeneous, the *passive* clot.

Ligature.—The application of the ligature to the feeding artery was almost the only method adopted by Surgeons for the cure of aneurism up to a comparatively recent date. The manner in which the ligature should be applied, and the various cautions respecting its use, have been sufficiently discussed (Vol. I., p. 423 *et seq.*). The question as to the part of the vessel to which it should be applied in aneurism, remains for consideration ; and this involves some important points.

Situation.—There are three situations in which the ligature may be applied : 1, *above and below the sac*, by the old operation ; 2, on the *cardiac side* of the sac, by Anel's (Fig. 454) or Hunter's (Fig. 455) operation ; 3, on the *distal side* of the sac, by Brasdor's or Wardrop's operation (Fig. 456).

1. The **Application of the Ligature on both sides of the Aneurismal Sac** is seldom practised at the present day, when the aneurism arises from disease of the coats of the vessel ; but in those cases in which it occurs from traumatic causes, it may frequently be adopted as the best means of cure, even in aneurisms of the largest size, as has been mentioned in the Chapter on Traumatic Aneurism (Vol. I., p. 462). The older Surgeons, however, were acquainted with this mode only of treating aneurisms, which was practised by Antyllus in the third or fourth century, and is often called by his name. The mode of applying the ligature to both sides of the sac is as follows. After having arrested the circulation through the aneurism, by compressing the artery leading to it, either by means of a tourniquet, or, where that is not applicable, by the pressure of an assistant's fingers, the Surgeon slits up the sac, turns out the contained coagula and masses of laminated fibrin, and then, passing a probe upwards and downwards into the artery, through the mouth of the sac, cleans the vessel and ties it on each side, immediately above and below the aperture. This operation, as performed by the older Surgeons on any of the larger arteries, as the popliteal, was not only so difficult in itself that they were seldom willing to undertake it, but was so fatal in its results, being commonly attended by secondary hæmorrhage, or by diffuse inflammation, suppuration, and gangrene in the deeper tissues of the limb, that recovery after its performance was considered a marvel, and amputation was generally preferred to it. At the present time, however, the difficulties are much diminished by the bloodless method of operating, and the subsequent dangers by the improved methods of treating wounds. The operation may, therefore, be undertaken with less hesitation as a last chance of saving a limb in which an aneurism has become diffused. Its applicability will be further discussed with the special aneurisms in the treatment of which it has been employed.

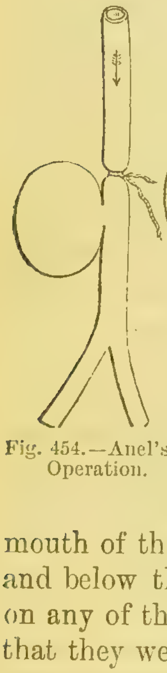
Fig. 454.—Anel's Operation.

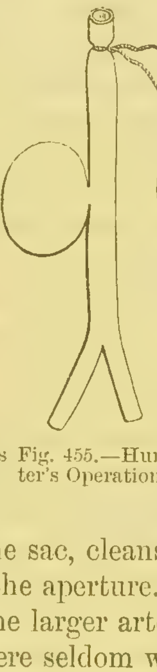
Fig. 455.—Hunter's Operation.

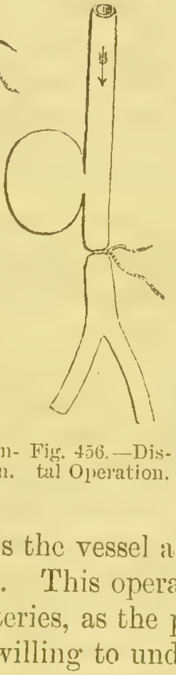
Fig. 456.—Distal Operation.

2. The **Ligature of the Artery on the Cardiac Side of the Aneurism,** without opening the sac, was first done by Anel, in the year 1710, in a case of brachial aneurism. This operation, though attended with the risk of wound or inflammation of the sac, which was in close proximity to the seat

of ligature, constituted a considerable advance in the treatment of the disease, inasmuch as it did not necessarily lead to the opening up of the aneurismal tumour, and to the dangers that were inseparable from that mode of procedure. As Anel, however, performed his operation as a mere matter of convenience in a particular case, and without the recognition of any new principle of treatment being involved in it, it attracted but little attention at the time, and does not appear to have been repeated by any of the Surgeons of his day.

It was reserved for John Hunter to make the great improvement in operative surgery of *ligaturing the artery at a distance from the sac.* In this way the objections to Anel's operation were avoided: for though, like Anel, Hunter tied the artery on the cardiac side only of the sac, yet he differed from him in doing so in a healthy part of its course, and at a considerable distance above the tumour, where the application of the ligature would be attended with less risk of hæmorrhage, and without the danger of opening, or exciting inflammation in the sac, which is inseparable from Anel's operation. The following are the reasons, given in Sir Everard Home's own words, that induced John Hunter to adopt the operation which is now generally known in surgery as the *Hunterian.* "Mr. Hunter proposed, in performing this operation, that the artery should be taken up at some distance from the diseased part, so as to diminish the risk of hæmorrhage, and admit of the artery being more readily secured should any such accident happen. The force of the circulation being thus taken off from the aneurismal sac, the cause of the disease would, in Mr. Hunter's opinion, be removed; and he thought it highly probable that, if the parts were left to themselves, the sac, with the coagulated blood contained in it, might be absorbed, and the whole of the tumour removed by the action of the animal economy, which would consequently render any opening into the sac unnecessary."

Hunter's first operation was performed in December, 1785, in a case of popliteal aneurism. The femoral artery was ligatured rather below the middle of the thigh, underneath the sartorius muscle; and from that time his method was almost exclusively employed by Surgeons in the treatment of aneurism, until the introduction of compression in 1842.

The **Effects produced upon an aneurismal tumour** by the ligature of the artery according to the Hunterian method, deserve careful attention. The immediate effect, on drawing the ligature tight, consists in a cessation of pulsation and bruit in the tumour, which at the same time subsides, becoming partially emptied of its blood. The supply of blood to the limb being in a great measure cut off, it becomes numb and cold, with a diminution of muscular power. The more remote effects consist in an increase of the activity of the collateral circulation, by which the vitality of the limb is maintained. At the same time, and, indeed, in consequence of this, the temperature of the limb often rises, until it becomes higher than that of its fellow.

The consolidation of the aneurismal tumour begins as soon as the ligature is applied, and is usually completed in a few days, by changes taking place within it similar to those that occur in the spontaneous cure of the disease. This important change is effected by the gradual deposit of stratified fibrin in concentric layers within the sac, and occasionally by the sudden coagulation of its contents. For the cure to be accomplished by the deposit of laminated fibrin, it is necessary that, though the direct flow of blood through the tumour be arrested by the ligature of the main trunk, some should yet be carried into it by collateral channels. This is a condition very favourable to the success of the ligature; for, if it happen that all the flow of blood through the tumour is arrested, coagulation of that which happens to be contained in it will ensue, and a soft yielding clot be formed, which is more likely to lead to unfavourable results than the firm products of slow coagulation. It is of importance to observe, that the proper consolidation of the aneurismal tumour, by the deposit of laminated fibrin, will occur even though a very considerable quantity of blood continue to flow through it. In the Museum of University College there is an exceedingly interesting preparation that is frequently referred to in connection with this point. It is one in which Sir Charles Bell ligatured the femoral artery for popliteal aneurism. The patient died a week after the operation, from erysipelas: on examination, it was found, and is shown by the preparation, that the femoral artery was double, and that, though only one portion of the vessel had been ligatured, the tumour, which continued to be supplied by the other branch, was completely consolidated. It is doubtful, however, in this case whether the consolidation was due so much to the diminished influx of blood to the tumour consequent upon ligature of artery as to the feebleness of the heart's action before death and possibly to some blood-change induced by the septic disease of which the patient died. After the aneurismal sac has been thus occluded, it progressively diminishes in size, and is at last converted into a small mass of fibroid tissue. The artery that has been ligatured becomes closed at two points—at the part deligated (Fig. 457, *a*), and where it communicates with the sac (Fig. 457, *b*). In both these situations, it will be found to be converted into fibroid tissue; whilst between them there is an open space, through the medium of which the collateral circulation is freely carried on.

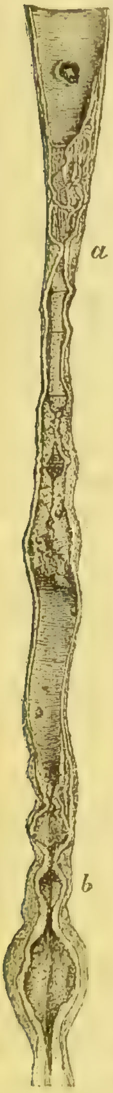

Fig. 457.—Femoral Artery ligatured for Popliteal Aneurism, obliterated at *a*, the site of the Ligature, and at *b*, where the Tumour has become consolidated and absorbed: between these points the Artery is open, and collateral branches enlarged.

3. **Distal Ligature.**—In some cases in which the ligature cannot, for anatomical reasons, be applied on the proximal side of the aneurism, as in the arteries about the root of the neck, it was recommended by Brasdor, a French Surgeon about the middle of the last century, that the vessel should be tied on its *distal* side. This operation, originally proposed by Brasdor, was first performed by Deschamps in 1799 at La Charité in Paris in a case of femoral aneurism. In principle, it resembles the Hunterian operation, the object being to arrest so much of the flow of blood through the sac that the consolidation of this may take place in the usual way, by the deposit of laminated fibrin. In the Hunterian operation, this is effected by deposit from the lessened quantity of blood that flows through the sac; in the distal operation, it is sought to be accomplished in the same way, and the success of the operation must necessarily depend, in a great measure, upon the extent to which the flow of blood through the sac is interfered with. This operation, however, is rarely

successful; for, independently of the ordinary dangers resulting from the application of the ligature to a large vessel, the sac will continue to be distended with, and to receive the direct impulse of, the blood that is driven into it. The natural result of the ligature would be to increase the general arterial tension and with it that of the sac; but, as Holmes points out, the enlargement of the collateral circulation opens, as it were, "side-sluices" to relieve this pressure, and consequently after a few hours or days the sac is usually found to be less tense than before the operation. Hence the progress of the aneurism may be arrested for a time, but it will often speedily increase again, and may perhaps eventually destroy the patient by suppuration and sloughing. Of 38 cases in which this operation was practised on the carotid artery, in 25 a fatal result more or less speedily followed the operation; in the remaining 13 cases the patients survived the effects of the ligature of the artery, though in very few if any of the cases were they cured of the disease for which the operation was performed. This operation will be considered more in detail in speaking of the particular cases in which it has been practised (see Chap. xliv.).

Indications and Contra-indications of Ligature.—Ligature of an artery for aneurism, by the Hunterian method, succeeds best in those cases in which the tumour is circumscribed, of moderate size, slow in its growth, having a tendency to consolidation, and unaccompanied by much œdema of the limb. When the aneurism is undergoing spontaneous cure, no surgical interference should be employed, but the case should be left to nature. In this way it occasionally happens, during the preparatory treatment of the disease, that the aneurism becomes consolidated.

Before the Surgeon proceeds to cut down upon an artery with the view of tying it, he should, as far as practicable, ascertain by a careful examination of it, whether it appears to be in a healthy state at the point at which he is about to tie it. He should feel along its course to ascertain if it be smooth, easily compressible, and natural to the feel; if it be hard, incompressible, indicative of calcification; if it feel broader than natural; if a bruit be heard in it on applying the stethoscope. If there be evidence of degeneration or dilatation of its coats, great caution should be used in attempting to ligature it. Should the deligation of a diseased artery become unavoidable, the antiseptic catgut, or the ox-aorta ligature, would probably be the best material for the purpose. The ends being cut short, and the wound closed over them, the chance of sloughing and of ulceration of the vessel would be greatly lessened.

It has occasionally, perhaps more frequently than the profession knows, happened to Surgeons that they have cut down upon an artery with the intention of tying it, and found it in so diseased a state that the application of the ligature was impracticable, and that it became necessary to close the wound without completing the operation. Liston and Aston Key have both had the candour to record such cases. In one case that happened to me in which it was thought necessary to tie the superficial femoral for popliteal aneurism, I found, on cutting down on the artery, that there was a small aneurismal dilatation just below the origin of the profunda, and a tubular dilatation of the artery below this, rendering the application of a ligature utterly impracticable. I afterwards tied the external iliac, but unsuccessfully. It must also be remembered that, in such cases as these, the vein is usually adherent, and consequently liable to perforation in passing the aneurism-needle between it and the artery. And even could deligation be practised, secondary hæmorrhage would undoubtedly occur at an early period in an artery incapable of obliteration in the normal way.

No operation should be performed when there is any serious disease of the heart, or in cases of multiple aneurism where the second tumour is situated internally; but it has happened that two aneurisms in one limb, as of the popliteal and femoral arteries, have been cured by one ligature applied to the external iliac. Two aneurisms seated in corresponding parts of opposite limbs, affecting, for instance, the two popliteal arteries, may be successfully operated upon. But, if two aneurisms be seated on different parts of the body, as the axilla and groin for instance, at the same time, extensive disease of the arteries is usually indicated, and it certainly would not be expedient to operate.

In certain cases, the Hunterian operation seldom succeeds. This happens in those instances in which it is necessary to apply the ligature very close to the sac, so as indeed rather to perform Anel's operation, as here there is the double danger of inflaming or wounding the sac, and of interfering with the collateral circulation of the limb. Those cases, also, in which the aneurism is very acute in its progress, increasing rapidly with forcible pulsation, having very fluid contents, and a large mouth to the sac, into which the blood is consequently driven in a full wave at each pulsation of the heart, are rarely favourable for the use of the ligature, inasmuch as stratification seldom occurs. When the aneurism is situated in the midst of loose and very yielding tissues, as in the axilla, where it readily expands to a large size, not being bound down by the surrounding parts, suppuration and sloughing of the sac are especially apt to occur after ligature. When it is diffused widely through the limb, with coldness and a tendency to incipient gangrene, the circulation of blood through the part is so much choked that deligation of the vessel will in all probability arrest it entirely, and thus produce mortification. When arteries can be felt to be calcified, it is a question whether they can be safely ligatured, as in all probability the changes necessary for their occlusion will not take place. Porter, however, recommends that the ligature should be applied in such cases, though I cannot but doubt the propriety of this advice. When inflammation has been set up in the sac, with a tendency to suppuration of the tumour, it is a debatable question whether the ligature should be applied or not. In these cases I agree with Hodgson, that the artery should be tied; for even if the sac eventually suppurate, there will be less risk to the patient if this occur after the application of the ligature, than if it happen while the artery leading into the tumour is pervious. If suppuration have already taken place around the sac, the application of the ligature above the inflamed tumour on the point of bursting would be worse than useless. In such cases, the line of practice must be determined by the seat of the aneurism. If this be in the axilla, groin, or neck, it should be laid freely open, the coagula scooped out, and the artery tied above and below the mouth of the sac—a most formidable and doubtful operation, but the only one that holds out a chance of success. If the aneurism be in the ham or calf, amputation would probably be the best course to pursue.

In some instances, there is no resource left to the Surgeon but to amputate.

1. Amputation must be performed when the aneurism is associated with carious

bone or a diseased joint, as when a popliteal aneurism has produced destruction of the knee. 2. If the aneurism have attained so great a magnitude that it has already interfered seriously with the circulation through the limb, as indicated by considerable œdema, lividity, and coldness of the part, with distension of the superficial veins, it is a question whether the application of the ligature may not immediately induce gangrene, and whether the patient would not have the best chance of recovery by submitting to amputation at once; this is more particularly the case when the aneurism, whether previously large or small, has become diffused and gangrene is impending, when removal of the limb must not be delayed. 3. If gangrene have actually supervened and the patient's strength be sufficient to bear the operation, amputation should be done without delay. 4. If a diffused aneurism in the lower extremity, whether suppurating or not, have been opened by mistake for an abscess, an attempt may sometimes be made to save the limb by laying open the sac and ligaturing above and below its mouth, but more often immediate amputation is required.

The mortality after ligature of the larger arteries for aneurism is very considerable. Thus, in 256 cases of ligature of the larger arteries for aneurism, collected and tabulated by Crisp, it would appear that the mortality amounted to about 22 per cent. And Porta finds that, among 600 cases of ligature of arteries for diseases and injuries of all kinds, the mortality amounted to 27 per cent. It must be borne in mind, that these are collections of reported cases, and that, if the unrecorded cases could be got at, the rate of death would, in all probability, be found to be much higher even than that above stated.

Accidents after Ligature for Aneurism.—The accidents that may follow the application of the ligature in a case of aneurism, are: 1, Secondary Hæmorrhage from the seat of ligature; 2, the Continuance or the Return of Pulsation in the Sac; 3, the occurrence of Suppuration and Sloughing of the Tumour, with or without hæmorrhage from it; and 4, Gangrene of the Limb.

1. **Secondary Hæmorrhage** from the seat of ligature presents nothing peculiar, and has already been discussed in Vol. I., p. 450.

2. The **Continuance or return of Pulsation** in an Aneurismal Sac after successful obliteration of the artery leading to it, by the ligature, is an interesting phenomenon, and one that deserves much attention. When the Hunterian operation is successfully performed, though the pulsation in the sac be entirely arrested, a certain quantity of blood continues to be conveyed into and through it by the anastomosing channels, and it is from this that the laminated fibrin is deposited by which the consolidation of the tumour is ultimately effected. This stream of blood furnished by regurgitation, or by transmission through the smaller collateral channels, is continuous, and not pulsatory; occasionally, however, it is transmitted in sufficient quantity by some more than usually direct and open anastomosing branch, and thus gives rise to a continuance or to a return of the pulsation. It is interesting to observe that, in some of the cases in which this has happened, there has been a return of the bruit, but in the majority no sound appears to have been emitted.

The *period* of the return of the pulsation in the sac after the ligature of the artery varies greatly. In the great majority of cases, at least two-thirds of those in which it has happened, a certain degree of thrill or indistinct pulsation has been found in the sac shortly after the application of the ligature; at all events within the first twenty-four hours. This may be looked upon as being rather a favourable sign than otherwise, as it is indicative of the free state of the collateral circulation, and it generally soon disappears spontaneously, the sac undergoing consolidation. Next in order of frequency are those cases in which the pulsation returns in about a month or six weeks after the ligature of the artery, the collateral circulation having been fully established, and, after continuing for some length of time, gradually ceases. It more rarely happens that the pulsation returns between these two periods; that is to say, about ten days or a fortnight after the application of the ligature; though in some instances the slight vibratory thrill, scarcely amounting to a pulsation, which perhaps is perceptible a few hours after an artery has been tied, gradually strengthens at the end of a week or ten days into as distinct and forcible a beat as had been noticed before the operation. In some rare instances the pulsation has re-appeared after the lapse of some months, the aneurismal tumour having in the meanwhile undergone absorption; then indeed it may with justice be looked upon as constituting a *secondary aneurism*, and as indicating a recurrence of the complaint.

The *cause* of the continuance or of the return of the pulsation in an aneurismal sac, must be looked for in too great a freedom of the collateral circulation. Indeed, it is an essential requisite for the manifestation of this phenomenon, that there should be so free and direct a communication between the artery on the proximal side of the ligature, and that portion of the vessel situated between the ligature and the sac, or the sac itself, as to enable the impulse of the heart to be transmitted in a pulsatory manner into the tumour. No regurgitant blood coming upwards from that portion of the artery which is distal to the sac, however free it may be, can communicate an impulse, as it never flows *per saltum* except in the special case of a continuous circle of large anastomoses, such as are met with between the arteries within the skull, or in the palmar and plantar arches. If any of the direct collateral or feeding vessels happen to be sufficiently large at the time of the operation to transmit the wave of blood, the pulsation in the sac will be continuous, or will return almost immediately after the application of the ligature. If they be at first too small for this, they may become enlarged as part of the anastomosing circulation, and then the pulsation will return as soon as their calibre is sufficient to transmit the heart's impulse. Besides these conditions in the size and distribution of the vessels of the part, it is not improbable, as has been supposed by Porter, that certain states of the blood in some individuals may, from causes with which we are unacquainted, render it less liable than usual to coagulate, and thus dispose to a return of the pulsation in the sac, which remains filled with fluid blood.

The phenomenon under consideration has been noticed in all parts of the body after the performance of the Hunterian operation, though it occurs with different degrees of frequency after the ligature of different arteries, and is certainly of more common occurrence after operations for carotid aneurism than for any other form of the disease. Thus, of 31 cases in which the carotid artery was tied for aneurism, I find that pulsation in the tumour continued or returned in 9 instances; whereas of 92 cases of inguinal aneurism, in which the external iliac artery was ligatured, the pulsation recurred in 6 cases only;

and in several of these it is interesting to note that there were two aneurismal sacs in the same limb—one in the groin, the other in the ham; and that the pulsation, though permanently arrested in the popliteal, recurred in the inguinal aneurism. In the ham and axilla, pulsation occasionally though very rarely recurs. This difference in the frequency of the recurrence of pulsation in different aneurisms, is evidently owing to the different degrees of freedom of communication that exist between the sac and the collateral branches in various forms of the disease; thus in a carotid aneurism, the impulse of the heart may at once be brought to bear upon the contents of the sac, through the medium of the circle of Willis. But, in the case of inguinal, femoral, or popliteal aneurism, the anastomoses, consisting rather of the inosculations of terminal branches than of open communications between large trunks, are less liable to transmit the blood in a pulsatory stream. For the same reason—the great freedom of the communication between the vessels of opposite sides—the pulsation has more frequently been found to continue uninterruptedly and distinctly, though reduced in force, after the ligature of the artery in carotid aneurisms, than in those in any other situation. The cases in which it returns after the cessation of a few hours only are perhaps as frequent in the groin and ham, as in the neck. In those instances in which the pulsation returns within the first twenty-four hours after the ligature, it usually ceases again in a few days, though it sometimes continues a week or two. When it recurs at a later period, it is apt to last somewhat longer. Compression antecedent to the ligature may so enlarge the collateral vessels as to favour a continuance or return of pulsation. I have once known the pulsation continue, though very much lessened, in a popliteal aneurism, after ligature of the superficial femoral, in a case in which treatment by compression had been tried unavailingly for nearly three months. In another case, in which I tied the external iliac artery for popliteal aneurism, owing to the superficial femoral being too diseased to admit of a ligature, the pulsation ceased completely for a time as I was tightening the ligature, but then returned, and became very marked in a few hours. In this case compression had been unavailingly employed before the artery was tied.

The *prognosis* of these cases is on the whole favourable, but few of them having eventually proved fatal. Of 26 patients in whom pulsation occurred, I find that three died; and in all of these the fatal result was occasioned by inflammation and sloughing of the sac. In all three instances, the pulsation recurred within the first twenty-four hours. When it returns at a more advanced period, there is little risk to the patient, as it is usually readily amenable to proper treatment.

A **Secondary Aneurism** is of extremely rare occurrence; indeed I believe there are only two unequivocal instances of this affection upon record, both of which took place in the ham; the original tumour having disappeared entirely after operation, the secondary disease made its appearance after a lapse of six months in one case, and in the other after four years. It is of importance to distinguish between a secondary aneurism and secondary or recurrent pulsation in an aneurismal sac. The term "*secondary aneurism*" should be restricted to those cases in which an aneurismal tumour appears in the site of a former one, which has undergone consolidation and absorption. The question may be raised, whether aneurisms of this kind are in reality secondary or whether they may not originate in the dilatation of a portion of the artery contiguous to the seat of the former disease. It is certainly not very easy to understand how an aneurismal sac that has once undergone consolidation and absorption, can again become dilated into a pulsating tumour; and I think it most probable that, although the consecutive aneurism may be found in the same surgical region as the primary one, it in reality takes its origin from a slightly higher part of the artery, where the same structural change may have been in progress that determined the disease in the first instance at a lower point. Double aneurism thus arising is, indeed, occasionally met with in the ham as a primary disease. I have seen a case in which an aneurismal tumour was situated in the ham, and another at or immediately above the aperture in the adductor muscle: if the artery in such a case as this had been tied before the second tumour had attained any magnitude, we can easily understand how, when this became dilated, it might have been considered to be a new enlargement of the original sac, whereas, in reality, it was nothing more than a new aneurism forming in close vicinity to the old one.

Enlargement of an aneurismal sac without pulsation after the ligature of the artery leading to it, is an interesting phenomenon, and one that might cause the true nature of the tumour to be misunderstood, as it closely resembles in its slow and gradual increase the growth of a malignant tumour. It is occasioned by the distension of the sac by regurgitant blood brought into it through the distal end of the vessel, without sufficient force to cause pulsation, though with sufficient pressure to occasion a gradual increase in the size of the swelling.

Treatment of Recurrent Pulsation.—In by far the majority of cases of secondary pulsation, this phenomenon ceases of itself in the course of a few days or weeks from consolidation of the sac; in the same way as after ligature of the artery, by the deposition of lamellated fibrin. This tendency to consolidation of the tumour may be much assisted by means calculated to lessen the force of the impulse of the blood into the sac, such as compression of the artery above the point ligatured, rest, the elevated position, and the application of cold to the part; cold, however, must be carefully applied, lest, the vitality of the limb being diminished, gangrene be induced. At the same time, direct pressure may be made upon the sac, so as to moderate the flow of blood into it: this has in many cases succeeded in procuring consolidation of the tumour, and may most conveniently be applied by means of a compress and narrow roller. This plan is especially adapted to popliteal and inguinal aneurisms, but cannot so well be exercised upon those situated in the neck. Care must be taken that the pressure be not at first too powerful, lest gangrene result: the object is not so much to force out the contents of the tumour, or to efface it, as simply to restrain and moderate somewhat the flow of blood into it. Should the aneurism be so situated that pressure can be exercised upon the artery above the point ligatured, this should be had recourse to either by the finger or by instrument, and will be both safer and more likely to be effectual than direct pressure. I succeeded in this way in curing a very remarkable case of recurrent pulsation in a popliteal aneurism. The patient, a man about thirty-five years of age, was admitted into University College Hospital for an aneurism, about the size of an orange, in the right ham. Treatment by compression was employed, without any effect being produced in the tumour, for three months. During this period compression was employed in all forms—by Carte's instrument, the weight, the finger, and flexion. I then tied the superficial femoral artery in Scarpa's triangle with a hemp ligature. The pulsation was arrested in the tumour when the ligature was tied, but returned in a slight degree in about an hour, and slowly increased, never becoming at all forcible, but being very distinct. The ligature separated on the fourteenth day. The limb was bandaged, and a pad applied over the aneurism without any effect; and the limb was raised, but still the pulsation continued. Carte's compressor was again applied to the common femoral artery, and used for about three hours in an intermittent manner, when the pulsation finally ceased.

In the event of the pulsation not disappearing under the influence of pressure, conjoined with rest, dietetic means, and the local application of cold, there are three courses open to the Surgeon: 1, To ligature the vessel higher up; 2, to perform the old operation of opening the sac; and, 3, to amputate, if the aneurism be situated in a limb.

With regard to ligaturing the artery at a higher point, I am not acquainted with any cases that throw much light on the probable result of such an operation. We know that the ligature of an artery high up for secondary hæmorrhage, after previous deligation of it, is a most disastrous procedure. But here the conditions are by no means identical with, or even similar to, those that accompany recurrent pulsation. In the case of secondary hæmorrhage, there has usually not been time for the full development of the collateral circulation; whereas, in the case of recurrent pulsation, many weeks would probably have elapsed before the second operation would become necessary, so that ample time would be given for the enlargement of the anastomoses; and besides this, the very occurrence of the return of pulsation may be taken as evidence of an unusually free anastomosing circulation. I think, therefore, that if such a case were by any possibility to occur, in which recurrent pulsation could not be checked by the application of pressure, digital or instrumental, to the artery above the point originally ligatured, aided by the other appropriate local and constitutional means that have been mentioned above, the Surgeon would adopt the proper course by ligaturing the artery higher up, *ex. gr.*, the common femoral or external iliac, if the superficial femoral had been the one previously tied. In the event of this not being thought advisable, he must choose between the two remaining operations, viz., amputation, or opening the sac. The operation of opening the sac, turning out its contents, and ligaturing the vessel supplying it, is in any circumstances a procedure fraught with danger to the patient, and full of difficulty to the Surgeon, even when he knows in what situation to seek the feeding vessel. How much greater then must the difficulty be, when he is in uncertainty as to the point at which the artery enters the sac, and cannot know whether there be more than one arterial branch leading into it. Still, if the limb be made bloodless by Esmarch's method, these difficulties may be overcome, and it is well, therefore, to attempt the operation whenever possible, falling back at once on amputation if it cannot be brought to a successful conclusion. If the Surgeon succeeds in the old operation the subsequent dangers of secondary hæmorrhage or profuse suppuration are very much reduced in the present day by efficient antiseptic treatment.

In those situations in which amputation is impossible, the Surgeon must attempt the old operation if it be practicable, or leave the patient to inevitable death. Smythe, of New Orleans, as a last resource, laid open a subclavian aneurism, for which he had successfully tied the innominate some years before, but failed to secure the artery, and the patient died. Morris, however, has successfully adopted this proceeding in a case of carotid aneurism after ligature of the common trunk had failed; and Berkeley Hill in a case of axillary aneurism after ligature of the subclavian.

Since the introduction of absorbable ligatures into surgical practice, a return of pulsation has in a few cases been due to a restoration of the lumen of the artery after the disappearance of the ligature. This is recognized by the presence of pulsation in the vessel at the point at which it was tied. These cases belong to a different class to those in which the vessel has been permently occluded, and require different treatment. The artery may be ligatured again at or near the same spot or at some other point. In a case of this kind that occurred under the care of Christopher Heath in University College Hospital, the femoral was successfully tied in Hunter's canal after ligature of the artery in Scarpa's triangle had failed. The causes of failure of the ligature have already been described (Vol. I., p. 430).

3. **Suppuration and Sloughing of the Sac.**—When, after the ligature of its supplying artery, an aneurism is about to suppurate, instead of diminishing in size, it increases, with heat, pain, pulsation, and some inflammatory discoloration of the skin covering it. This gradually becomes thinned, and at last gives way; the contents of the tumour, softened and broken down by inflammation and the admixture of pus, are discharged through the aperture in its wall, in the form of a dark purplish brown or plum-coloured and often fœtid fluid, intermixed with masses of soft dark coagula, or of the drier laminated fibrin, which may not inaptly be compared in appearance to portions of raisins or dates. The discharge of these matters, variously altered, may be accompanied or followed by the escape of florid arterial blood. This hæmorrhage, which is the great source of danger in the suppuration of an aneurismal sac, may occur in a sudden violent gush, by which the patient may at once be destroyed, at the time of the rupture of the tumour: or it may continue in small quantities, and, after ceasing, recur from time to time, thus gradually exhausting the patient. It is this occurrence of secondary hæmorrhage that constitutes the principal danger after suppuration of an aneurism, which otherwise is not a source of any very serious risk to the patient; about one-fourth only of the cases in which the sac has suppurated having had a fatal termination, and almost all those in which death resulted having proved fatal by hæmorrhage. The patients in a few remaining instances have been carried off by some special accidents, such as the pressure of the sac on the pharynx or œsophagus, or the discharge of the contents of the tumour into the pleura or bronchial tubes. Hæmorrhage is more liable to occur when suppuration takes place a few weeks after the ligature of the artery, than when a longer interval has elapsed. That hæmorrhage does not happen more frequently after suppuration of the sac is very remarkable, and must be owing either to the sealing by adhesion or plugging by coagulum of the mouth of the aneurism, where it communicates with the interior of the artery. It is owing to this plugging also, that in many cases the fatal bleeding does not occur at the moment of rupture, but only after a lapse of some days, or even weeks, and then, as a rule, owing to some incautious movement of the patient by which the coagulum or adhesion is suddenly disturbed. Those cases are most dangerous in which pulsation has returned in the sac after the ligature of the

vessel, but before the supervention of suppuration ; as in these the tumour is so freely supplied with blood that, if it burst, fatal hæmorrhage will with certainty occur.

This accident is much more frequent in some situations than in others, and is more liable to occur in aneurisms of the axilla or groin, than in those of the ham or of the neck. The proximity of the ligature and the necessary interference with the sac in its application, especially in large axillary or inguinal aneurisms, is undoubtedly a frequent cause of it. The large size these tumours rapidly attain, in consequence of the laxity of their areolar connections, also favours it. Until recently it was believed that the occurrence of simple coagulation, instead of gradual deposit of laminated fibrin, was an important factor in the production of suppuration of the sac ; but our late experience of the treatment of aneurism by rapid compression clearly shows that the danger has been greatly exaggerated. In other cases it is probable that the suppuration of the sac is a consequence of pyæmic infection from the wound, corresponding to those cases in which we find the formation of pus occurring in injured or diseased tissues at a distance from the septic wound. Besides this, it has been very justly remarked by Porter, that the excessive handling and frequent examination to which an aneurismal tumour is usually subjected in a hospital, may induce inflammation and predispose to suppuration.

The *period* at which suppuration of the sac may occur after the ligature, varies from a few days to as many months. In the majority of instances, it would appear to take place between the third and eighth weeks ; later than this it seldom happens, though it may do so after the lapse of several months, as in a case recorded by Sir A. Cooper, in which a carotid aneurism suppurated at the eighth month.

Treatment.—When an aneurism is suppurating, and is on the point of giving way, it will be better to make an incision into it with antiseptic precautions, so as to let out the broken down contents at once. It must then be treated like an ordinary abscess, with a view to its filling up by granulation ; which, however, will necessarily be a slow process, in consequence of the great size and depth of the opening. During the whole of this time a tourniquet should be kept loosely applied upon the artery above the sac, so as to be tightened at any moment if bleeding take place. If hæmorrhage have already supervened, the case is attended with immediate danger. In such a case as this, the first indication is clearly to arrest the flow of blood, so as to prevent the patient from dying at once. This can best be accomplished by turning out the coagula and plugging the sac with lint or compressed sponge, retained *in situ* by a firm graduated compress, and well applied roller. The hæmorrhage having thus been arrested for a time, the Surgeon should consider what steps should be adopted permanently to restrain it. In some cases, indeed, though these are exceptional, the plug and compress may be sufficient to prevent a recurrence of the bleeding ; but in general it will not do to trust to these means, unless the anatomical relations of the part be such as to preclude more active measures.

Various plans are open to the Surgeon for the permanent suppression of the bleeding. The sac may be laid open, and an attempt made to ligature that portion of the artery from which the blood issues. But this can scarcely be expected to succeed, as, in the majority of the cases, the coats of the vessel being softened, there would be little prospect of its holding a ligature, even if it were possible to expose it before the patient perished of hæmorrhage. Indeed, though this plan has been several times tried, I am not aware that by it the Surgeon has ever succeeded in arresting the bleeding from a suppurating aneurismal sac.

The application of the actual cautery to the bleeding orifice would, I think, hold out a better chance, more particularly if the blood were poured out from a collateral vessel of a small size. In this way, Morrison, of Monte Video, succeeded in arresting the bleeding of an aneurism in the groin that had suppurated. Should this means, however, not suffice (and it is the only means that can be applied in many situations, as in the groin and axilla), there is no course left but, in those situations in which it can be done, either to ligature the artery higher up or to amputate. The application of a ligature nearer the centre of the circulation, even though practicable, appears to me to be of very doubtful utility; for the probability is, that the circulation through the limb, embarrassed as it must have been by the first ligature, and by the subsequent distension and suppuration of the sac, will be so much interfered with when the artery is tied a second time, that gangrene will result; or else that the collateral circulation, if sufficiently active to maintain the vitality of the limb, will also keep up the hæmorrhage from the opening in the artery communicating with the sac. In these circumstances, the only course left to the Surgeon is amputation of the limb when the aneurism is so situated that it can in this way be removed.

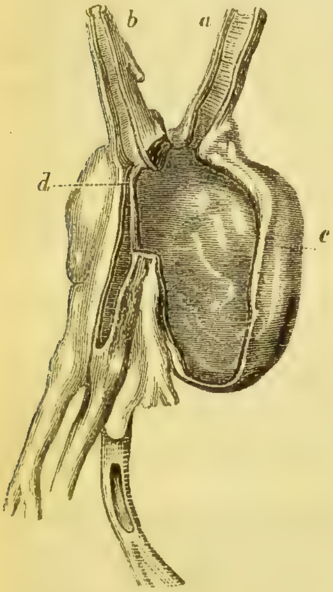

Fig. 458.—Popliteal Aneurism compressing the Vein, and thus causing Gangrene of the Limb: *a*, Artery; *b*, Vein compressed at *d*; *c*, Aneurism.

4. **Gangrene of the Limb.**—The general subject of gangrene of a limb, following injury and ligature of the main artery, has already been described (Vol. I., p. 458); and we have at present to consider only those cases in which it occurs after the operation for aneurism.

Causes.—If the aneurismal sac have attained a large size with great rapidity, it may, by its *pressure* on the collateral vessels, or on the veins in its vicinity (Fig. 458), produce such an amount of disturbance in the circulation of the limb, preventing the influx of arterial or obstructing the efflux of venous blood, as to occasion a great liability to the occurrence of gangrene. But perhaps the principal source of danger consists in the *aneurism becoming suddenly and widely diffused*, more particularly in those cases in which the anatomical relations of the collateral vessels are such, as in the ham, that they may readily and uniformly become compressed by the effused blood. In these cases, the additional embarrassment induced in the circulation of the limb by the ligature of its main artery will readily induce gangrene; and hence it is that, in diffuse aneurism of the lower extremity, ligature of the artery is so commonly followed by mortification.

Loss of blood, either in consequence of secondary hæmorrhage, or in any other way before or after the application of the ligature, is very apt to be followed by gangrene; the more so, if it have been necessary to apply a ligature to a higher point on the trunk of the vessel than had previously been tied. This secondary ligature of a large artery in cases of aneurism has, I believe, been invariably followed by gangrene of the limb, when done in the lower extremity; the interference with the collateral circulation by the second ligature being so great, that the vitality of the part cannot be maintained.

Besides these causes, the occurrence of *erysipelas*, exposure of the limb to *cold*, or to an undue degree of *heat*, or subjecting it to the *compression* of a bandage, may be attended by consequences fatal to its vitality.

The *period of supervention* of gangrene of the limb is usually from the third to the tenth day; it seldom occurs before this period, unless incipient mortification have already set in before the artery was tied. Gangrene usually follows the ligature of the external iliac at an earlier period than that of any other artery. In cases of aneurism, the gangrene is always of the dark and moist variety, owing to its being commonly dependent on pressure upon the large venous trunks by the aneurismal tumour.

Treatment.—The general preventive treatment of gangrene following the ligature of the artery for aneurism must be conducted on the same principles as when it arises after the ligature of arteries generally (Vol. I., p. 460). But some special modifications of it are required, so far as the aneurism is concerned. When the gangrene occurs from the pressure of the sac upon the accompanying vein, it has been proposed to lay the tumour open, and to turn out its contents, thus removing the compression. The danger of such a proceeding consists in the probability of the occurrence of hæmorrhage from the opening made into the sac, and in the risk attending suppuration set up in the sac; yet it would appear that, in two cases in which this practice has been adopted, no bad results followed. Thus, Lawrence has related a case of diffused aneurism of the popliteal artery, in which this plan was had recourse to with the best results; and Benza has recorded a case of popliteal aneurism in which the same method was adopted in consequence of great œdema and incipient gangrene of the foot; after the extraction of a quantity of flesh-like fibrin from the sac, the patient made an excellent recovery. These cases would certainly justify the Surgeon in adopting such a course when the danger of gangrene is imminent, and dependent on the size and pressure of the tumour. Should, however, the gangrene show any disposition to extend, or should there be hæmorrhage from the sac after it has thus been laid open, the Surgeon must hold himself in readiness to amputate without delay. When gangrene has once fairly set in, there is no reasonable prospect of saving the limb; and the sooner amputation is done the better. The limb must always be removed high up above the sac, and if possible, not only at some distance from the parts that have mortified, but also above the part to which the serous infiltration that precedes mortification has extended. The upper extremity must generally be removed at the shoulder-joint; the lower above the middle of the thigh. In these cases there will generally be a considerable amount of hæmorrhage, and many vessels will require to be tied in the stump, in consequence of the enlargement of the collateral circulation.

Compression by Instruments.—In consequence of the dangers and difficulties attending the use of the ligature, Surgeons have endeavoured to treat aneurism by compression. The employment of direct pressure on the aneurism was almost naturally suggested as a means to counteract the extension of the disease by the pressure of the blood from within, and has consequently been applied from a very early period in the treatment of the affection. This plan was first employed by Bourdelot at the close of the seventeenth century; afterwards by Genga, Heister, Guattani and others. These Surgeons made the pressure directly upon the sac; and Guattani and Flajani relate several cures that they effected in this way; but the method was so uncertain in its results, and so dangerous from its tendency to cause inflammation of the sac, that it fell into disuse. The French Surgeons introduced a modification of the pressure plan, by laying open the sac, clearing out its contents, and applying the pressure directly over the opening into the vessel. Deschamps exposed the artery leading to the sac, and compressed this with an instrument which he termed the "*presse-artère.*" These barbarous modes of treatment, however, were entirely set aside by the facility and comparative success of the Hunterian operation; and compression in aneurism was rarely practised by Surgeons after the great step made by John Hunter in the treatment of this disease. Yet we find that John Hunter himself, Blizard, and Freer attempted, though without success, to cure this disease by pressure on the artery leading to the sac. Pelletan and Dubois appear to have been the first who successfully applied pressure to the artery above the sac, instead of to the aneurism itself; this was in 1810. After this period, various attempts were made methodically to treat aneurisms in this way; but the merit of having introduced the practice of compression in the treatment of aneurism into modern surgery, of having given it a definite place in our art, and of having established the true principles on which it acts, incontestably belongs to the Dublin Surgeons; amongst whom the names of Hutton, Bellingham, Tufnell, and Carte deserve especial mention.

Principle of Compression.—In the early trials of the cure of aneurism by compressing the artery on the cardiac side of the tumour, the Surgeons who employed this method acted on an erroneous theory; and, the principle not being understood, the practice was bad. It was supposed to be necessary, in order that a cure might take place, that the *whole* flow of blood through the artery should be arrested; that inflammation of the vessel at the point compressed should be set up; and that the consolidation of the aneurism depended upon the obstruction of the vessel consequent upon this inflammation. This led to the employment of such violent and forcible compression, with the view of exciting inflammation in the artery, that the patient could seldom bear it for a sufficient length of time to effect a cure; sloughing of the skin commonly resulting from the severity of the pressure to which it was subjected. To the Dublin Surgeons belongs the very great merit not only of having pointed out the error of this doctrine, but of having distinctly laid down as the principle of the practice, that, in the majority of cases, the cure is brought about when the artery is compressed, in precisely the same way as when it occurs spontaneously, or when the Hunterian operation is performed—viz., by the deposit of stratified fibrin, and by the consequent consolidation of the aneurism (Fig. 459), aided by the contraction of the walls of the sac; and that, as in the case of ligature of the vessel, it was not necessary that the whole of the circulation through the aneurism should be permanently arrested, but merely that it should be lessened in quantity and force to such an extent as to be compatible with the deposition of laminated fibrin in the sac; and it was clearly shown by examination after death that, if the pressure were properly conducted, the artery was in no way injured or occluded at the part compressed. The recognition of the true principles on which compression of the artery leading to the sac cures the aneurism, has led to important results; for as the severe pressure that was formerly considered necessary is now known not only to be unnecessary, but to be absolutely injurious, no amount of compression is exercised beyond what is requisite to moderate the flow of blood into the sac; no attempt being made to compress the artery so severely as to lead to its obliteration by inflammation.

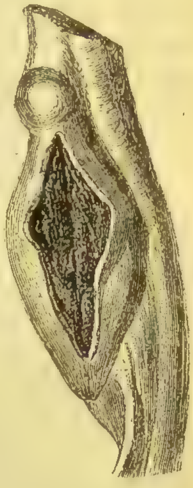

Fig. 459.—Sac of Aneurism cured by Compression: Deposit of Laminated Fibrin.

But, although, where the pressure is moderate or the anastomosing circulation free, the consolidation of the contents of the sac takes place in the way that has just been described, it would be an error to suppose that this is the process by which the aneurism becomes cured in all cases in which recourse is had to compression. There can be no doubt that in some cases, in which consolidation has taken place in a few hours after the employment of pressure, coagulation of the contents of the sac has suddenly occurred; and this sudden coagulation, which at one time was dreaded by Surgeons, has been found by increased experience to be in the highest degree advantageous, as leading to a more rapid cure.

In the tubular form of aneurism, which is far less frequent than the sacculated in the extremities, the cure appears to take place, if it occurs at all, rather by the gradual contraction of the partially emptied sac than either by the slow deposit of laminated fibrin, or by the rapid and almost sudden coagulation of its contents. The sac gradually shrinks, and shreds of fibrin only are found adherent to its sides. But although I believe that the condition of the aneurism, whether sacculated or tubular, has a considerable influence upon the mode in which compression acts in effecting a cure, and also upon the time that is occupied in the treatment, this being much shorter in the sacculated than in the tubular form of the disease; yet there can be no doubt that this is materially influenced also by two other circumstances—viz., the condition of the blood within the sac, and the completeness of the compression.

When the sac is filled with fluid blood, and the compression is not uninterruptedly complete, the sac appears to empty itself to a considerable extent, and eventually to consolidate by the deposit of laminated fibrin. But, if the sac already contain some solidified layers, and the compression be continuous and complete, the coagulation of the remaining fluid part of its blood is apt to take place rather suddenly. But in all cases the contraction of the sac, consequent upon the arrest or restraint of the current of blood into it. is an important element in the cure. Illustrative of this mode of cure, there is a preparation in the Museum of University College (Fig. 460).

From all this, then, it would appear that the consolidation and cure of an aneurism by compression may take place in three different ways: 1, by the slow deposit of laminated fibrin; 2, by rapid coagulation of the contents of the sac; 3, by contraction of the sac. The particular mode of cure will depend upon the completeness of the compression and the more or less perfect arrest of the blood in the sac, the coagulability of that blood, and the shape of the aneurism.

Circumstances Influencing Success.—The success of compression depends greatly upon a scrupulous attention to a number of minor circumstances, which, though each be trifling in itself, become of importance when taken together. During the whole time, also, the patient's general health should be attended to in accordance with those principles that have already been laid down in speaking of the constitutional treatment of the disease. The irritability of the system must also be lessened if necessary, by the use of opiates or of chloral; and the patient should be put into a comfortable bed, with firm and well-secured pillows and mattresses, so that his position may not be changed. As it is principally in aneurism of the lower extremity that compression can be employed, we shall proceed to describe the method of its application here.

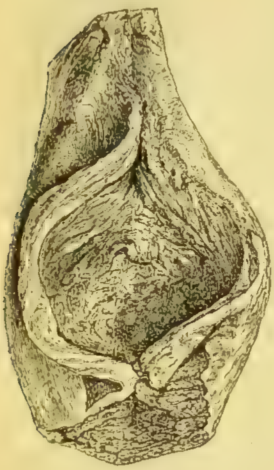
Fig. 460.—Sac of Tubular Aneurism cured by Compression: Contraction of Sac, and irregular Deposit of Fibrin.

Application of the Compressor.—The thigh should, if necessary, be shaved. The skin should then be powdered, and the limb bandaged with a soft roller; a pad being laid on the tumour. Pillows must then be comfortably arranged under it, the knee being semi-flexed. Much of the success of the treatment will depend upon the kind of instrument used. The ordinary horse-shoe, or Signorini's tourniquet, was the one first employed, and this will, in many cases, answer the purpose perfectly well; but, as it is somewhat difficult to regulate the pressure with this instrument, and as it is not unfrequently exercised too powerfully, it has generally given place at the present day to the very ingenious apparatus of Carte, which, as it substitutes an elastic force derived from vulcanized india-rubber bands for the unyielding pressure of the screw, accommodates itself better to the limb, and is less likely to produce injurious compression. This instrument, as well as the other contrivances which have at various times been invented for the treatment of aneurism by compression, are described by Bellingham and Tufnell, in their works on this subject, to which I must refer for a fuller account than I can here give.

In applying the compressor, especial care must be taken that it is well padded in every part, so as not to gall the skin. In some of the early cases in which I saw compression employed in London by means of the horse-shoe tourniquet, much inconvenience resulted from want of attention to this point. The tendency to fretting of the skin is much lessened by powdering the limb; and the removal of the hairs by shaving diminishes materially the irritation produced by the instrument. In order to keep up continuous pressure, and at the same time to prevent any one part of the skin from being injuriously galled, it is of very great consequence that two instruments should be used at the same time, so that when one is screwed down the other may be loose; these instruments need not be placed close together. If the aneurism be in the ham, it will be sufficient for one (Fig. 462) to be applied to the groin, whilst the other (Fig. 461) is put upon the middle of the thigh

(Fig. 463). In using the instrument, the great point, as Tufnell most properly remarks, is to control the circulation with the minimum of pressure. In order to do this, the first instrument should be screwed down so that all pulsation ceases in the tumour, but still not so tightly as completely to arrest all the flow of blood through it. As the pressure exercised by this becomes painful, the second compressor must be screwed tight, and then the first may be slackened. In this way an alternation of pressure can be kept up without much pain or inconvenience. If possible, the patient should be taught how to manage the instrument himself, and will often find occupation and amusement in doing so. If, however, it excite much pain or irritation, as it does in some subjects, it may be necessary to give opiates or chloral hydrate. The pressure should, if possible, be continued during sleep; but if it prevent the patient from taking his natural rest, the suggestion made by Tufnell, of unscrewing the instrument slightly, and, when the patient is asleep, gently tightening it again without awakening him, may advantageously be adopted; it is indeed surprising how very little unscrewing will relieve the pain of the compression. A large cradle should be placed over the patient's body, so that the weight of the bed-clothes may be taken off the apparatus, and that the patient may manage it without risk of disturbance. Should there still be much uneasiness, the instrument

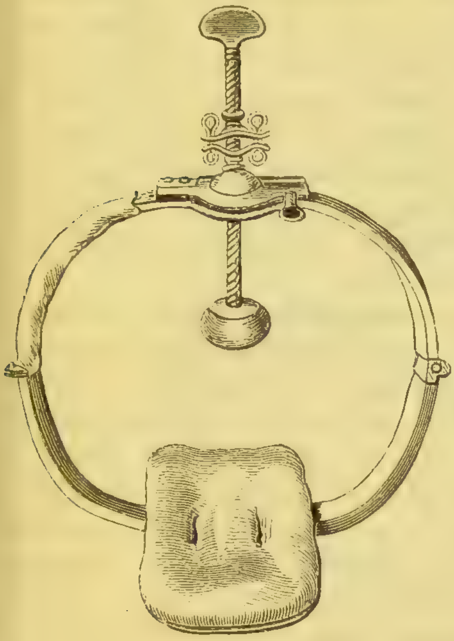
Fig. 461.—Compressor for the Middle of the Thigh.

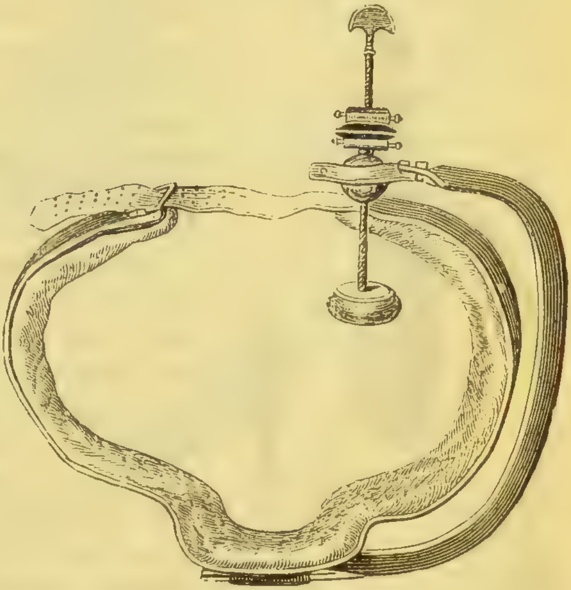
Fig. 462.—Compressor for the Groin.

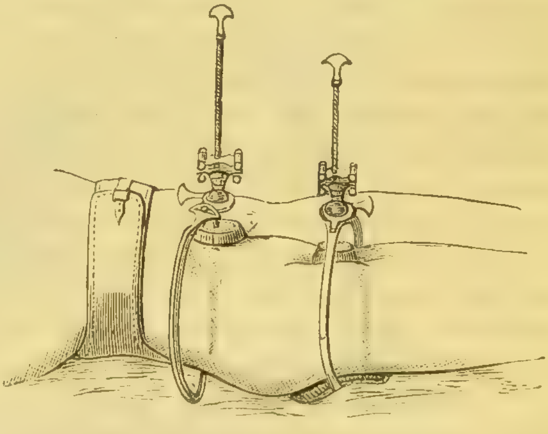
Fig. 463.—Two Compressors applied for Femoro-popliteal Aneurism.

might be taken off for a few hours, and compression kept up in an intermittent manner. Even in such circumstances as these, consolidation of the sac may ensue.

The employment of a *weight* may sometimes be advantageously substituted for the clamp, and often occasions less distress to the patient. For this purpose the apparatus (Fig. 464) will be found very useful. A very simple compressor is Tufnell's compressor, represented in Figs. 465, 466. It consists of little more than a truss-spring, with a pad to compress the artery, and straps to fix it in its place, and increase, by being tightened, the force of the compression.

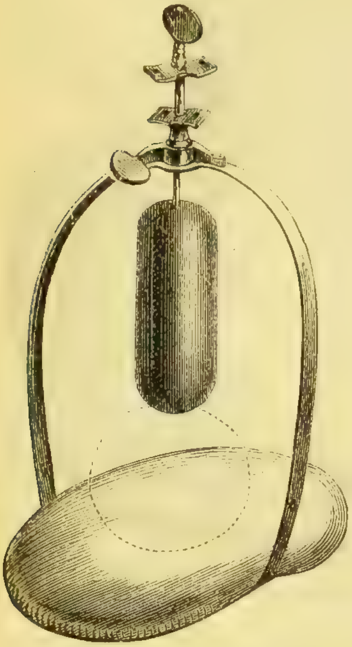

Fig. 464.—P. H. Watson's Weight Compressor. The circular dotted line shows the position of the limb.

Compression under Anæsthetics.—In some cases, in which, from the situation of the aneurism, deep and severe pressure is required to control the circulation, the pain becomes so unendurable that the patient cannot submit to the treatment sufficiently long for a good effect to be produced. Opium or chloral hydrate may then possibly enable him to bear the pressure, but more complete narcotism is often necessary. In these circumstances chloroform becomes a most useful adjunct; and by prolonging the anæsthesia for several hours, the amount and duration of pressure requisite to effect a rapid cure may be maintained. In this way W. Murray of Newcastle-on-Tyne—to whom is due the merit of first employing prolonged anæsthesia as an adjunct to compression—cured an aneurism of the abdominal aorta by keeping up pressure on that vessel for five hours under chloroform. Heath of the same town cured an aneurism of the external iliac by compressing the abdominal aorta for seven hours under chloroform: Mapother of Dublin treated an ilio-femoral aneurism successfully by compressing the common iliac artery for four and a half hours; and Lawson treated an inguinal aneurism successfully by pressure on the abdominal aorta for four hours. In two cases of popliteal aneurism I kept up completely obstructing pressure on the common femoral artery, under chloroform, for twelve hours. By these means the only serious objection to the employment of pressure, and the most common cause of its failure, may be prevented; and it is clear that, under chloroform, pressure may be applied to arteries, such as the subclavian and carotid, on which it could not otherwise be used.

The **Effects upon the tumour** vary considerably. In some cases it rapidly and suddenly solidifies; more commonly, however, this is a gradual process, the aneurism becoming more painful and more solid, with less pulsation and bruit. As the solidification takes place, there is usually some restlessness, a feeling of general uneasiness, and of constitutional disturbance, which is best quieted by opiates. As the pressure is continued, and the tumour begins to harden, the anastomosing vessels enlarge, with a good deal of burning pain in the limb generally, and arterial pulsations in situations where usually none are naturally felt. The abnormal pulsation in these cases, is always found to occur in much the same situations, the same vessels appearing to undergo dilatation.

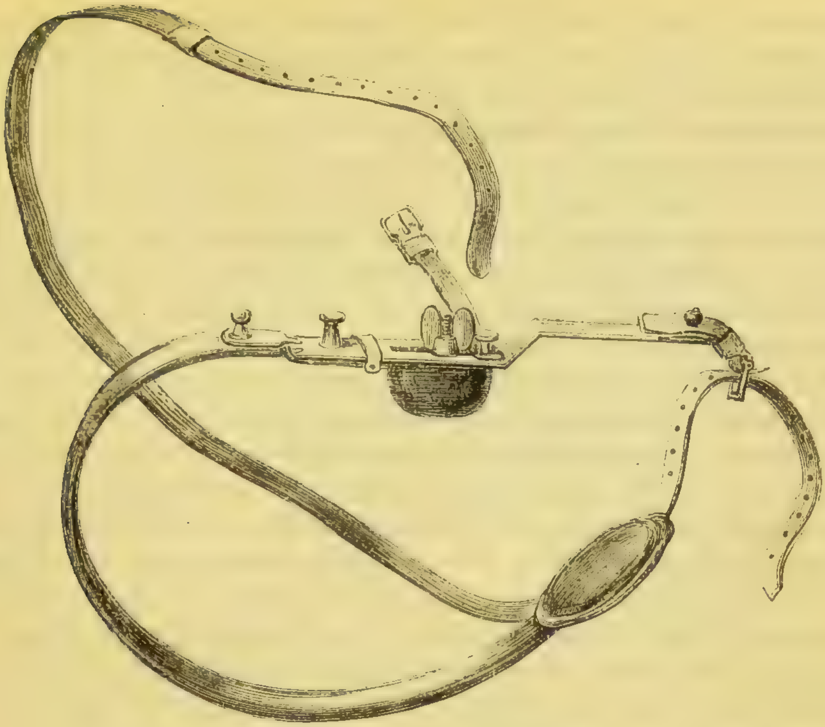

Fig. 465.—Tufnell's Compressor.

Thus Tufnell has made a remark, which I have had more than one opportunity of verifying, that in the treatment of popliteal aneurism by compression, three arteries will be found to be enlarged, one of which passes over the centre of the

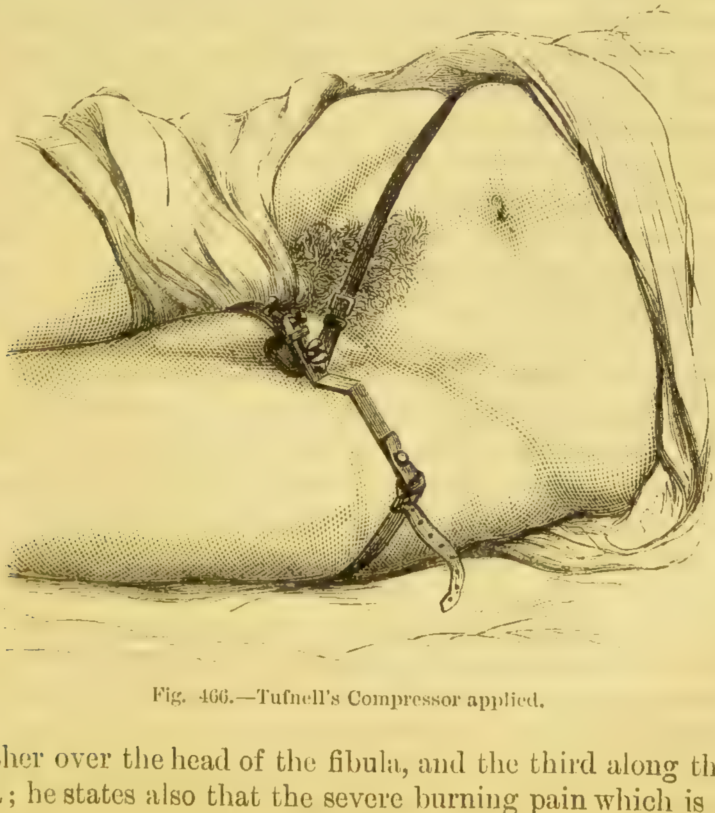

Fig. 466.—Tufnell's Compressor applied.

tumour, another over the head of the fibula, and the third along the inner edge of the patella; he states also that the severe burning pain which is felt in these cases is owing to the artery accompanying the communicans peronei nerve being enlarged. After complete solidification of the tumour has taken place, the compression ought to be continued for at least forty-eight hours, so as to guard against the occurrence of a relapse.

The **Duration of the Treatment** varies very greatly. In some cases, as above stated, the tumour has become solidified in a few hours or in two or three days. In other instances, the treatment has required to be protracted for more than three months before a cure has resulted. Of 26 cases of femoral or popliteal aneurism cured by compression in the London hospitals, the average time, according to Hutchinson, was nineteen days. Barwell has collected from American, British, and Continental journals all the recorded cases of popliteal aneurism cured by compression in the ten years 1870 to 1879 inclusive, and he gives the following statistics of the duration of the treatment. For instrumental compression the longest period was 7 weeks, the shortest 24 hours, the mean of 19 cases in which the time was recorded, 12 days ; for digital compression, the longest period was 21 days, the shortest 4½ hours, and the mean of 13 cases 5½ days ; for combined instrumental and digital compression the longest period was six months, the shortest 44 hours, and the mean of 12 cases 44⅓ days. Much, of course, will depend, in this respect, on the constitution of the patient, and on the condition of the tumour ; those circumstances which are most favourable to the spontaneous cure of the aneurism will also influence the rapidity of the cure by compression. There are, undoubtedly, certain conditions of the blood in which it is little disposed to coagulate, and in these cases the duration of the treatment will necessarily be prolonged. So also, when the aneurism is tubular, we must expect that the blood which passes freely through it in the direct current of the circulation will be slower in depositing layers of fibrin than when the disease is sacculated, and thus contains a residuum of blood that is not so directly influenced by the current through the sac. In the early days of the compression-treatment there was an indisposition on the part of Surgeons to apply it very effectually and firmly, and a longer time was expended over it than is now generally the case ; and the example set by Murray, with regard to abdominal aneurism, has been followed with success in respect to the femoral, popliteal, and other forms of the disease, the compressor being screwed down tight on the artery so as completely to arrest for the time all circulation through the sac, the patient being kept under chloroform, and the cure effected in a few hours.

Applicability.—Of the great value of compression in the treatment of aneurism, there can be no doubt ; more especially when the tumour is situated in the arteries of the lower extremity below the middle of the thigh. In aneurism occurring in the vicinity of the trunk, as in the iliac, the carotid, subclavian, and axillary arteries, it is generally not so applicable ; although, as we have already seen, aneurisms in the groin have been cured by compression of the abdominal aorta, or of the iliac artery. Spontaneous aneurism is extremely rare in the upper extremity ; and, as the traumatic forms of the disease which occur here generally require that the sac should be laid open, it is seldom found necessary to have recourse to it in this part of the body, though it may be and has been successfully applied to the brachial artery.

The great question with regard to compression appears, after all, to be whether it possesses any special advantages over the ligature, in the treatment of those aneurisms in which its employment is practicable. The principal objections that have been urged against it are, that its employment is more painful and tedious than the use of the ligature; and that those cases that are unpromising to the ligature, or that require amputation rather than deligation of the artery, are equally unfavourable to compression, and cannot be saved by its employment.

To these objections it may with justice be answered that the pain attendant on the employment of compression depends very greatly upon the skill and care with which the apparatus is applied and managed throughout, as well as upon the kind of instrument used, being certainly much diminished when Carte's elastic compressor is employed; and that, as has already been shown, the pain may be overcome by the use of anæsthetics. With regard to the relative tediousness of the treatment under the two plans, it would appear that in reality there is but little difference; for although some cases, in which compression is used, are prolonged over a considerable space of time, yet they do not occupy more than is often consumed when accidents of various kinds follow the use of the ligature; and it not unfrequently happens in compression, but can never occur after the employment of the ligature, that the patient is cured of his disease in a few hours or days. Taking, however, the averages, we find that in the Dublin cases the treatment lasted twenty-five days, and in the London cases collected by Hutchinson but nineteen, and this is not very different from what formerly happened when silk ligatures were applied so as to cut through the artery and be finally withdrawn from the wound; for of fifty-four cases recorded by Crisp in which the femoral artery was tied, the average time for separation of the ligature was eighteen days, and if to this a week more were added for the closure of the wound, and for the treatment of the various accidents that often accompanied and followed ligature, we should probably be within the mark, and yet only bring the duration of the treatment by the two methods to the same level. In the present day, however, ligatures which are either absorbable, or are intended to become enclosed in the wound, are almost universally employed; and, as with the improved methods of treating wounds, union by first intention, or within ten days, is the rule, the treatment by ligature has come to be the more speedy mode of cure.

Surgeons will, however, be eventually guided in their estimate of the value of these two plans, not so much by the question of submitting their patients to a slightly more painful or tedious treatment, as by the comparative risk to life attendant upon one or other method. Upon this point statistics have yet to be collected; partly because the unsuccessful cases of ligature have not been so commonly published as the successful ones, and partly because sufficient time has hardly yet elapsed since the general adoption of absorbable ligatures and of antiseptic treatment to enable us to form a correct conclusion as to the diminution in the death-rate that may be effected by their use. Statistics published by Bellingham in 1851 (Med.-Chir. Trans., Vol. XXXIV.), and by Holmes in his well known Lectures on the Treatment of Aneurism in 1874, showed clearly that though the treatment of popliteal aneurism by compression is attended by scarcely any direct danger to the patient, it very frequently fails to cure the disease. On the other hand, ligature of the femoral artery is far more certain as a means of cure though necessarily attended by more direct danger from the operation, a danger which the statistics show has progressively decreased during the last thirty years. The latest statistics on this subject are those published in 1883 by Barwell in his admirable article on Aneurism in the International Encyclopædia of Surgery. He has there collected 148 cases of popliteal aneurism treated by compression between 1870 and 1880. Of these, 68 were successful, while 80 ended in failure. Of the unsuccessful cases, 57 submitted to ligature, 2 went away unrelieved, 4 suffered amputation, and 6 died. Of the 6 deaths, 2 occurred from rupture of the sac, 2 from "thrombosis," 1 from gangrene, and in one the cause was not stated. During the same period, 67 cases of ligature occurred in six of the chief London hospitals. Of these, 10 died. If these are further subdivided, it will be found that out of 32 cases which occurred in the first half of the decade, 7 died and 2 underwent subsequent amputation; while from 1875 to 1879 inclusive, 35 cases occurred, with 3 deaths and no amputations. Whether this great improvement is merely accidental, or is the result of the improvement in the material used as the ligature and in the treatment of the wound, remains to be seen, but there is great reason to believe the latter is the true explanation.

If compression fail, ligature may be applied in some cases with a better prospect of success than if compression had not previously been tried, that treatment having caused the collateral circulation to enlarge, and thus lessened the tendency to gangrene. If, however, we take the general average of those cases that have been submitted to ligature after the failure of compression, we shall find that the result is not so satisfactory as when the ligature has been employed as the primary method of treatment. Thus I find that, out of 40 cases in which the ligature was employed after compression had failed, there were 16 deaths. This is probably not so much due to the previous employment of compression, as to the same causes interfering with the consolidation of the tumour after the ligature that had prevented the success of the compression-treatment. With regard to the facility of ligaturing an artery such as the femoral, after compression has been tried and has failed, it must be admitted that the difficulties are increased. The sheath of the vessels is apt to become thickened, and the artery and vein perhaps less easily separable than when pressure has not previously been employed. In fact, it must be said, that in such cases the Surgeon has not to do with a virgin artery.

It should also not be forgotten that in some cases, as when aneurism is complicated with heart-disease, or occurs in a very broken and unhealthy constitution, in which the operation necessary for ligature would be scarcely or not at all admissible, compression may be safely employed.

After carefully considering the relative merits of the two plans of treatment, I think we may conclude that, though in some few cases neither ligature nor compression can be adopted, and amputation is the sole resource, yet in others compression can be employed when it would not be safe to have recourse to the use of the ligature; and that, in all ordinary cases of femoral and popliteal aneurism especially, compression should be preferred to the ligature, inasmuch as it is not a more tedious, and is an infinitely safer method of cure. At the same time, it must not be forgotten that its success depends very greatly on the continuous care bestowed upon the case during the progress of the treatment.

Digital Compression.—Shortly after the introduction of the treatment of aneurism by instrumental compression, the fingers were used as an adjunct to the mechanical means in use. Thus Greatrex, in 1845, directed a patient to keep up compression by means of the fingers, where the tourniquet had been used, and required to be loosened. In the following year (1846) Vanzetti, then Professor of Surgery at Charkoff, tried, but unsuccessfully, to cure a large popliteal aneurism by compression of the femoral with the fingers only, continued for two days. It was not until seven years later, when Professor at Padua, that Vanzetti had an opportunity of putting this method successfully into practice, and to establish it as a distinct means of curing aneurisms. But although this merit is undoubtedly due to Vanzetti, we must credit Knight of Newhaven (U. S. A.) with the first successful case—he having, in 1848, cured a very large popliteal aneurism by digital compression, maintained for forty hours.

In this plan of treating aneurisms, no apparatus of any kind is used; but the circulation through the artery leading to the tumour is controlled by the pressure of the finger. In order to carry it out there must be relays of assistants, each of whom compresses the vessel for about ten minutes at a time. The pressure should be applied in the way that is represented in Fig. 18, Vol. I., p. 51. The fatigue may be very materially lessened by placing a 6 or 8 lb. weight on the compressing finger. With such aid each assistant may be able to keep up the pressure for half an hour at a time. As soon as his fingers become fatigued, but before he relaxes the pressure, another assistant compresses the vessel ; and thus the circulation through it may be uninterruptedly controlled. In this way aneurisms of the popliteal artery, in the orbit, at the bend of the arm, and in the groin, have been successfully treated —the tumour having in some instances become consolidated in a few hours. The effect of digital compression and the rapidity of cure, would be increased by the application of direct pressure to the tumour, and by the previous employment of proper constitutional means ; it might in some cases be very advantageously conjoined with the treatment by flexion. But its chief advantages seem to be, that it is applicable to arteries, as those at the root of the neck, to which it might be difficult to apply any kind of compressor, and that it can be employed when no apparatus is obtainable.

Esmarch's Elastic Bandage has been used with a certain amount of success in the treatment of external aneurisms. It was first employed in these cases by Staff-Surgeon (now Sir) Walter Reid. Pearce Gould, who has carefully investigated this method of treatment, has collected the details of 72 cases in which it has been employed. Of these he finds that 35 were cured, in 30 the treatment was unsuccessful, in 5 death resulted, and in the remaining 2 the result was doubtful.

The treatment has been applied chiefly to aneurisms of the popliteal artery, but in a few cases it has been successfully employed in other situations. The objects in view are, first, to empty the whole limb of blood as far as possible, with the exception of the sac and the part of the artery in immediate connection with it ; secondly, to keep the blood distending the sac at perfect rest until coagulation has taken place ; and thirdly, to protect the soft clot thus formed from the influence of the arterial current until it has become sufficiently tough and solid to resist it, by compression of the trunk leading to the aneurism. In the case of a popliteal aneurism, the treatment is thus carried out. The elastic bandage is first applied from the toes to the ham with sufficient force to render the limb bloodless ; it is then carried loosely over the tumour, so as not to empty the sac, and again applied firmly as high as the middle of the thigh ; the elastic tourniquet is then put on with sufficient force to arrest the circulation completely. The bandage is better left on till the tourniquet is removed. The average time required for the application of the bandage is one hour and a half. The time during which the limb may be kept bloodless with impunity is uncertain. Heath has kept the tourniquet on in one case for three hours, and in another for three and a quarter, without evil consequences ; and Barwell in one case retained it for five hours. The limb must be wrapt in cotton-wool, and, if necessary, warm bottles, at a temperature of about 100° F., may be applied. The pressure causes severe pain, which may require the use of hypodermic injections of morphia ; but if the treatment is continued for more than one hour, it is usually necessary to administer an anæsthetic. Before the bandage is removed a Carte's compressor may be applied, or arrangements made for keeping up digital compression, and this must be maintained for from two to six hours, even if all pulsation has ceased when the tourniquet is taken off.

The mode by which the elastic bandage effects a cure is by causing stasis of the blood in the aneurism and the adjoining part of the artery. This stagnant blood coagulates, the clot being formed first in the aneurismal sac, and then spreading to the artery. Gould is of opinion that the permanent cure of the aneurism is effected chiefly by means of the portion of coagulum extending into the artery. This being in contact with the comparatively healthy walls of the vessel undergoes the changes described in the chapter on wounds of arteries (Vol. I., p. 414) ; the vessel is thus permanently occluded. The clot in the aneurism, on the other hand, being in contact with the unhealthy walls of the sac, or with layers of laminated fibrin, tends to become friable, and to yield before the pressure of the blood, unless protected by the thrombus in the artery. If, however, the vessel be safely occluded, the sac and its contents gradually shrivel and are absorbed. Failure has in some cases apparently been due to the bandage having been applied too tightly over the tumour, so that the sac was but partly filled by the coagulum. In other cases it may have been due to a want of coagulability in the blood, and in order to avoid the possibility of this it is well to submit the patient to a course of medical treatment and diet (p. 118) before applying the bandage.

If, on removal of the bandage, there is still distinct pulsation to be felt, although the tumour seems partially consolidated, a cure may often be effected by digital or instrumental compression in a few hours.

The chief danger to be apprehended seems to be gangrene, which has occurred in more than one case. It appears to have been due to thrombosis taking place in the vein, and possibly also in the capillaries of the parts in the neighbourhood of the aneurism from which the blood had not been expelled. This, with the simultaneous occlusion of the artery, would offer an amount of obstruction to the circulation which would almost certainly end in gangrene. The only means of avoiding it seems to be by carrying the bandage lightly over the tumour, by which the veins may be emptied while the fulness of the sac is not interfered with. The expulsion of so large an amount of blood from the limb necessarily raises the arterial tension in the rest of the body : consequently the use of the elastic bandage is not to be recommended when the patient is affected with an internal aneurism which might rupture under the strain. For the same reason it should be avoided when there is a suspicion of fatty heart.

The elastic bandage is most likely to succeed in effecting a cure in aneurisms that are beginning to undergo consolidation. It is of little use in aneurisms that are large, rapidly increasing, with thin walls and fluid contents.

Flexion.—The treatment of aneurism by flexion of the contiguous joint is a method that is rarely applicable to any other form of the disease than the popliteal. The history of this plan of treating aneurisms is interesting, as an illustration of the gradual steps by which Surgery usually arrives at its ultimate results. It had been long known to Surgeons that the pulse at the wrist might be arrested by the forcible flexion of the forearm on the arm ; and Malgaigne and Richet had recommended this means for the arrest of hæmorrhage from the brachial artery and the arteries of the forearm when wounded. Fleury—a distinguished French naval Surgeon—having succeeded in curing a wound of the brachial artery by forced flexion of the elbow, aided by direct compression, and one of the radial by flexion of the wrist, published in 1846 a memoir, in which he stated, as a conclusion from his observations, that any aneurism of the forearm or leg might be treated by means of flexion of the limb in which it was situated. To A. Thierry is due the honour of having been the first to cure a traumatic aneurism of the bend of the arm by flexion of the limb. This was in 1852 (Richet, *Dict. de Méd. et de Chirurgie*, Vol. II., p. 338). In 1857, Mannoir of Geneva applied the flexion-treatment to a large aneurism of the ham. Forced flexion could not be borne on account of the pain it occasioned, and the patient was therefore allowed to walk on crutches with the leg bent, and supported in a kind of stirrup attached to the opposite shoulder. In less than three weeks the cure was effected, which Mannoir found a year afterwards to be permanent. In the following year, 1858, Hart applied this method of treatment successfully in a case of popliteal aneurism, and to him is due the merit of having first introduced it into this country.

Flexion is necessarily applicable only to arteries situated at the bend of joints, as the elbow or ham, in which the circulation can be directly controlled by bending the limb, or in traumatic aneurisms in the limbs below these joints, in which the flow of blood through the feeding artery can be stopped in the same way. Its application is therefore somewhat limited, and its use is still further restricted by the pain and insupportable annoyance occasioned in many cases by forced flexion of the limb, necessitating, as in Mannoir's case, a relaxation of the method, which, however, was still effective in curing the aneurism.

Nothing can be simpler than the details of this plan. It consists, in the lower limb, in applying a bandage as high as the knee and then gradually flexing the leg upon the thigh, so that the heel is brought up towards the buttock, where it is retained by a strap or bandage. The patient is at the same time confined to bed, and put under proper constitutional treatment. By this means, the popliteal artery being bent at an acute angle, the circulation through it is nearly, if not completely arrested ; and the obstacle to the flow of blood is still further increased by the compression of the tumour between the posterior flat surface of the femur and the upper part of the calf. In this way the aneurism is most favourably situated for the consolidation of its contents, which, in the recorded cases, has often taken place at an early period.

The principle on which the cure is effected in these cases appears to be, that by flexion the artery leading to and from the sac, and the aneurism itself, are so compressed that retardation of the circulation ensues, and deposition of laminated fibrin takes place in the usual way. The compression by flexion is most likely to be attended by success in those cases in which the aneurism is small, situated low in the popliteal space, and in a young or middle-aged subject, who can bear the continued flexion without much inconvenience. When flexion is not sufficient of itself to cure an aneurism, it may very advantageously be had recourse to in addition to other methods of treatment, more especially that by digital compression.

The statistics of the treatment by flexion require to be carried down to the present time. Those published by Fischer in 1870 comprised 57 cases. Of these 28 were cured—20 being by flexion alone; and in 29 the method failed.

The various methods of employing compression, viz., by clamps, by weight, by flexion, and by the finger, may often be advantageously combined in the same case. When the patient tires of one, another may be substituted for it: and thus the good effects are continuously kept up with less fatigue and irritation than would otherwise be experienced. So also various modifications of these different methods may be practised to suit the requirements of any particular case. But for these no special directions can be given; the ingenuity of the Surgeon must supply the want in each case.

Manipulation.—Sir W. Fergusson proposed to treat some aneurisms by a procedure which he termed *manipulation.* This consists in squeezing the aneurismal tumour in such a way as to detach a portion of the coagulum within it, which, being carried on with the current of blood into the distal end of the artery, obstructs this; and thus, by impeding the circulation through the sac, may lead to the gradual consolidation of the tumour; and it has also been suggested by Oliver Pemberton that the alteration of the relations of the laminated fibrin in the cavity of the aneurism may bring about a further deposition of fibrin on the displaced laminæ. This procedure can scarcely be considered, nor is it intended to be, of very general application. To aneurisms, however, that are not amenable to ordinary surgical treatment, and that must necessarily prove fatal if left, as those situated at the root of the neck, more particularly of the subclavian artery, it might possibly be advantageously applied. It is scarcely necessary, however, to point out the obvious danger of rupture of the sac, or of the diffusion of the aneurism from the weakening of its walls by the separation of the coagulum, to make Surgeons use due caution in carrying out this method of treatment. There is another danger also especially attendant on this procedure, when applied to aneurisms about the neck; viz., that the detached coagulum may be carried by the circulation into the cerebral arteries, and by obstructing them occasion the same kind of cerebral disturbance that occurs when these vessels become occluded by fibrinous plugs—embola. That this danger is a real and a great one, is evident from the fact that, in some cases in which manipulation of subclavian and carotid aneurisms has been tried, the patient has been suddenly seized with syncope and hemiplegia. Teale has successfully conjoined manipulation with compression in a case of popliteal aneurism, in which the pressure on the artery was slow in consolidating the tumour; the detachment of a portion of the coagulum almost at once led to the consolidation of the tumour. Somewhat analogous to this method is one recommended in 1842 by Blake, who proposed, by the introduction of a cataract-needle into the sac, to detach some of the laminated fibrin, which might then be washed against the aperture of the exit and occlude it.

GALVANO-PUNCTURE.—The attempt to procure the consolidation of an aneurismal sac by the employment of electricity is of comparatively recent date. It appears to have been first practised by B. Phillips, about the year 1832. Little attention, however, was given to the mode of treatment until a few years back, when it was revived by some of the French and Italian Surgeons, especially Pétrequin, Burci, and Ciniselli. The object aimed at by this operation is the production of coagulation in the aneurismal sac by decomposition of the blood contained in it by means of the galvanic current. When two needles connected with the poles of a galvanic battery are introduced into a mass of fluid blood, a firm solid coagulum is rapidly formed round that connected with the positive pole, while at the same time a large, soft, spongy clot mixed with bubbles of gas is seen at the negative needle, and a dark, tar-like fluid also makes its appearance. If the needle used be made of steel, further changes occur at the positive pole due to the production of salts of iron with the acids liberated from the blood. These changes are spoken of as secondary electrolysis. The clot formed by electrolysis is, therefore, not composed simply of the fibrin of the blood, but contains also a large proportion of albumen coagulated by the chemical action of the current, and must be looked upon as a foreign body around which we hope ordinary coagulation will occur.

The operation of galvano-puncture is best performed as follows. Two steel needles, well insulated with vulcanite or gum elastic, are inserted into the sac of the aneurism and connected with the opposite poles of the battery. The needles should be about one inch apart, parallel to each other, and so inserted that no part of the uninsulated portion of the needle shall touch the sac. The best battery for the purpose is one of the ordinary medical batteries with small Leclanché cells, of which from ten to twenty may be used for a time varying from twenty minutes to half an hour, or more—according to the effect produced. If the tumour be sufficiently near the surface to be clearly observed, as has been the case in several of the aneurisms in which the treatment has been employed, it will be seen to become more tense and firm, and the expansile nature of the pulsation will become diminished as the operation progresses. Sometimes bubbles of gas escape by the side of the negative needle, and a little thick brown fluid oozes up. Occasionally the tumour has been found to swell and become resonant on percussion. When a distinct effect has been produced the needles may be withdrawn, and the small punctures closed with lint and collodion. The negative needle will be found unaltered, while the positive will be corroded in direct proportion to the amount of electrolytic action that has taken place. In order to prevent this corrosion of the positive needle, it has been suggested by Dr. John Duncan that platinum may be used instead of steel. There is no evidence, however, that the salts of iron produced give rise to any particular danger; in fact, it is probable they aid considerably in the formation of the firm coagulum surrounding the needle. The battery used in the operation is of considerable importance. It has been pointed out by Ciniselli, that a current of high tension and somewhat low intensity is less likely to cause the production of undue heat during the operation, and consequently less prone to lead to inflammation and suppuration of the sac. A battery, therefore, composed of a large number of small elements is superior to one of a few large elements. Some operators, and especially Bastian, have advocated the introduction of the positive pole only, the negative being attached to a sponge or metal plate laid on the skin near the aneurism. The only objection to this mode of treatment is the excessively small effect produced. The electrolytic action which takes place is directly in proportion to the intensity of the current ; and by the inclusion of a considerable mass of the tissues of the patient in the circuit, the resistance is so greatly increased that electrolysis is reduced to a scarcely appreciable amount, the positive needle appearing almost unchanged after the operation. Others, again, have introduced the negative needle only, but as the coagulum formed at the negative pole is soft and frothy, but little good can be expected from this mode of operating. Julius Althaus, who has superintended the operation in five cases, is strongly of opinion that "the most effective application of the current is that where both poles are inserted into the sac." Ciniselli operated in this way, and Duncan and Fraser, to whom we are indebted for many important observations on galvano-puncture and for the invention of reliable insulated needles, support the same view. The operation is accompanied by but little pain, and it is only occasionally that chloroform is needed. The effect of a single operation is seldom sufficient to cause any marked improvement in the condition of the patient, and it usually requires to be repeated several times.

The clot formed as the result of galvano-puncture is somewhat soft and yielding, and unless supported by a moderately firm sac soon flattens out or disappears, and the condition of the aneurism becomes much the same as it was before the operation. Little more than the most temporary relief can for this reason be expected in many cases ; and whenever the aneurism has become diffused, the operation can only be productive of mischief by hastening the inflammatory changes occurring round the sac. It might be supposed that so soft a clot would readily break up, and that there would consequently be great danger of embolism ; but no such accident has happened in any of the recorded cases. Suppuration of the sac has occasionally taken place, but its occurrence has been much less frequent since the principles of the operation have been more fully understood. The formation of sloughs round the needle-punctures, and consequent hæmorrhage, has not been noticed except when the needles have been imperfectly insulated. In fact, it may be said that in almost every case, even when the operation has failed to give relief, it has at any rate done no harm.

The general results of the published cases have not been unfavourable when we consider the hopeless nature of the cases in which it has been performed. Ciniselli asserts that of 13 cases of aneurism of the aorta treated by his method, five were cured, and no evil consequences followed in any case. Of the same number which have been operated on in this country during the last few years, none have been cured, but at least six experienced more or less relief ; and in almost all, it may be said, the operation aimed only at relief, the disease being too advanced to warrant any hope of cure. About sixty other cases of aneurism of various arteries have been collected by Ciniselli as having been operated on before 1868; but in these the methods used were so imperfect, that they cannot be fairly considered as bearing upon the question at the present time.

When we compare galvano-puncture with ligature or compression in the treatment of external aneurism, it is, I think, impossible to hesitate for a moment in giving a decided preference to the latter modes of treatment, as the results that have hitherto been obtained from the former are not such as would justify a prudent Surgeon in submitting his patient to an operation of this kind, when he possesses such certain and comparatively safe modes of treatment as deligation or compression. In internal aneurisms, or in those cases in which the disease is so situated at the root of the neck, that the artery can neither be ligatured with safety nor compressed, galvano-puncture is certainly justifiable, especially when conjoined with proper medical treatment, as we have ample proof that with the knowledge and means now at our disposal we can perform the operation with scarcely any danger to the patient, and in favourable cases with some hope of relief. Much will depend upon the selection of the case. Ciniselli has pointed out that the conditions favourable to success, are that the aneurism shall be sacculated and opening into the vessel by a narrow mouth, of slow growth and of medium size, and, when thoracic, situated entirely within the thorax, and that it shall not in any serious way have interfered with the general health of the patient. These conditions seldom occur; and when they are absent, the most that can be hoped for is temporary arrest of the progress of the disease and some relief to the patient's sufferings.

INJECTION WITH PERCHLORIDE OF IRON.—The injection of aneurismal sacs with a solution of perchloride of iron has also been practised, with the view of coagulating their contents, but such treatment is attended by considerable risk of embolism, and is liable to give rise to inflammation and suppuration. Its employment would, therefore, be suggested only in cases on which either from the situation of the aneurism, or its complication with extensive disease of the arterial system, neither proximal nor distal ligature nor compression is applicable, and in these probably the introduction of foreign bodies into the sac or galvano-puncture would be less dangerous and equally likely to be successful. Gamgee has suggested the injection of fibrin-ferment into the sac, while the circulation through it is arrested by pressure, as a means of determining coagulation. This has been once practised by Southam in a case of iliac aneurism, but without success.

HYPODERMIC INJECTION OF ERGOTIN.—Langenbeck advocated the hypodermic use of a watery extract of ergot in cases of aneurism, under the impression that it might act on the muscular fibres scattered over the sac of the aneurism in the same way as it acts on the muscular fibres of the uterus, and by causing contraction might gradually diminish the size of the aneurism, if not cure it. He seems to have tried it in only two cases. One was an aneurism in the supraclavicular region (exact nature not mentioned), which had been previously treated with moxas, and almost cured. The symptoms having returned, hypodermic injections of ergot were tried. The quantity injected varied from about $\frac{1}{2}$ grain to 3 grains of Bonjean's watery extract of ergot, diluted with three times as much spirit and glycerine. The injections were repeated every three or four days. Decided improvement is said to have occurred, but pulsation never quite ceased. The improvement commenced after the second injection. No unpleasant symptoms occurred after the injections. In the second case a man, aged 42, had a sacculated aneurism of the radial artery of the size of a hazel-nut. An injection of two grains and a half of the watery extract cured it in one day, as the next day it could not be felt. The injection gave rise to some inflammation of the surrounding cellular tissue, which disappeared in a week.

This accident I have seen happen in one case in which I tried it, but no good resulted from the treatment, which cannot, indeed, on pathological grounds, be considered to be of a hopeful character.

INTRODUCTION OF FOREIGN BODIES.—In 1864 Moore introduced twenty-six yards of fine iron wire into the sac of an aortic aneurism through a fine trochar, with the view of inducing coagulation of its contents. The tumour appeared to become more solid, but death took place on the fifth day from inflammation of the sac and pericarditis. Since that time the operation has been repeated about a dozen times without any very encouraging degree of success, the only cure having occurred in a case of a small brachial aneurism in a young woman under the care of Van der Meulin. In this case catgut was used instead of wire, and the treatment was combined with compression. In 1883 Loreta introduced two metres of wire into the sac of an abdominal aneurism after exposing it by opening the abdomen. The man apparently recovered, but died after ninety-two days from rupture of the sac close to the mouth. In 1873, Bryant introduced twenty-six feet of horse-hair into a popliteal aneurism in a patient dying from ulcerative endocarditis, and thus averted the threatened rupture of the sac, prolonging life for a few days. In 1885, Hulke introduced forty feet of wire into an aortic aneurism, with the result of consolidating a part of the sac which threatened to give way, but eleven weeks after, the tumour was enlarging so rapidly in another direction that the operation was repeated by Gould, but without success. These seem to be the only cases in which any marked benefit has followed the operation. The true value of this treatment has yet to be determined. It is evidently only justifiable when more efficient means are inapplicable, and in such cases it may do something to arrest the progress of the disease. Opinions differ as to the best material to be used. Steel wire, which has been rolled upon a reel so that it may again coil up in the sac, seems the most convenient in many ways, and if too much be not introduced it is not likely to cause any irritation in the sac. Horse-hair and catgut are less under control, and may project through the mouth of the sac into the main trunk, although so far there has been no evidence of embolism following their use. The treatment is probably useless after the aneurism has become diffused by the yielding of its sac.

Barwell has in one case of aortic aneurism combined electrolysis with the introduction of steel wire. Ten feet of fine steel wire were passed into the sac through a hollow needle made of ivory. The wire was then connected with the positive pole of a battery, and the negative being applied to the skin of the back. Some consolidation followed the operation, but the patient died on the ninth day from rupture of the sac. A considerable amount of firm colourless clot was found adhering to the wire, but what part electrolysis took in its production is doubtful.

ACUPUNCTURE with very fine needles has been performed with some benefit in a few cases, and if carefully carried out, can hardly be productive of any injury. It was first suggested by Velpeau, and practised without success by Dunville and Agnew. Marshall has in more than one case obtained in this way some consolidation in aortic aneurisms, and Macewen succeeded in curing a popliteal aneurism by the introduction of a fine needle while the femoral artery was compressed. Heath adopted the same treatment in a case of subclavian aneurism in University College Hospital after he had unsuccessfully amputated at the shoulder-joint. Six fine needles were introduced into the sac in such a way as to cross each other, and were left in for four days, at the end of which time the tumour was much firmer. The patient died about twelve days after from causes unconnected with the treatment, and a considerable amount of firm clot was found in the sac. This treatment seems worthy of further trial in otherwise hopeless cases as a substitute for galvano-puncture. The smallest sewing needles with heads made of sealing-wax may be used, as in Heath's case; or better still, the fine pins known as entomological pins, which should be gilded. They may be left in for from four to five days, and it is perhaps safer to cover them with some simple antiseptic dressing to diminish the risk of ulceration. After they are removed the punctures must be covered with collodion.

ARTERIO-VENOUS ANEURISMS.

Preternatural communication between arteries and veins, though usually the result of wounds, occasionally happens from disease; ulceration taking place between the vessels, and thus causing an opening from one into the other. When such communications are of traumatic origin, they may, as has already been stated, constitute either an *Aneurismal Varix* or a *Varicose Aneurism*. As the result of disease, aneurismal varix only can occur, varicose aneurism never happening except as a consequence of wound. These spontaneous communications have been met with between the aorta and the vena cava, and between the iliac, femoral, carotid, and subclavian arteries and their accompanying veins. In nature, symptoms, course, and treatment they so closely resemble traumatic aneurismal varix, described at p. 467, Vol. I., that their consideration need not detain us here.

SPECIAL ANEURISMS.

CHAPTER XLIV.

ANEURISMS OF THE THORAX, HEAD AND NECK, AND UPPER EXTREMITY.

ANEURISM OF THE THORACIC AORTA.

SYMPTOMS.—The symptoms of intrathoracic Aortic Aneurism are of two kinds: *auscultatory* and *rational.*

The **Auscultatory Signs** vary greatly in distinctness, and may even be wanting. In some cases, more especially in fusiform aneurisms, they are very marked almost from the first; in others, especially in sacculated aneurisms, they may be absent throughout. They consist in murmurs of various kinds and degrees of intensity—bellows, rasping, or whizzing: and in the second sound of the heart being audible over a greater space than normal. At the same time there may be dulness on percussion. These various signs may often be heard more distinctly upon or to the left side of the spine, than at the anterior part of the chest; when occurring anteriorly, they are chiefly met with on the right side.

The value of the auscultatory signs in the diagnosis of aneurism within the chest is not perhaps so great as in many other thoracic diseases, in the early stages of the affection, and in those cases in which the aneurism continues small and sacculated throughout, or is so deeply seated as not to approach the parietes of the chest. This need not be a matter of surprise, when we reflect how deeply the ascending portion of the aorta and the arch are situated; how they are covered in front by the lungs and loose areolar tissue, through which sound is with difficulty transmitted; and how they are covered in behind by the spine and its muscles. When, in addition to this, it is borne in mind that aneurisms of the arch often prove fatal by bursting into contiguous cavities and canals before they have attained a size greater than that of a walnut or a pigeon's egg, and thus are incapable of furnishing a murmur of any very marked kind, it can be easily understood that the value of auscultation is but small in many cases of thoracic aneurism.

The **Rational Signs** of intrathoracic aortic aneurism are of three kinds:—Pressure-Effects; Pulsation; and Tumour.

Pressure-Effects may be exercised on any of the contiguous structures: and a glance at the anatomical relations of the thoracic aorta, more particularly the arch, will enable the Surgeon to judge of their complexity and importance. They will necessarily vary according to the size of the aneurism and the portion of the aorta affected by it; more according to the latter than to the former condition. When the aneurism arises from the *root of the aorta*, and more especially when it is intrapericardial, it is usually of small size, and its pressure effects will be little obvious. When the aneurism arises from the *termination of the arch*, or the *descending aorta*, it may often attain a considerable development without causing any very obvious pressure-effects. Aneurisms that are situated *within the concavity of the arch* necessarily give rise to very severe effects, by the compression they must exercise upon some one or other of the very important structures that are included within the aortic arch. When the *anterior part of the aorta* is affected, the aneurism may attain a very considerable bulk, even coming forward so as to project and pulsate between the intercostal spaces, without any very noticeable pressure-effects being induced. But when the *posterior wall of the artery* is the seat of the disease, then severe symptoms are early set up by the compression and erosion of the structures lying contiguous to the artery and along the spine (Fig. 467). When the *upper part of the aortic arch* is the seat of aneurism, a peculiar train of cerebral symptoms, such as vertigo, insensibility, or defective vision, may be induced by its interference with the circulation through the carotids.

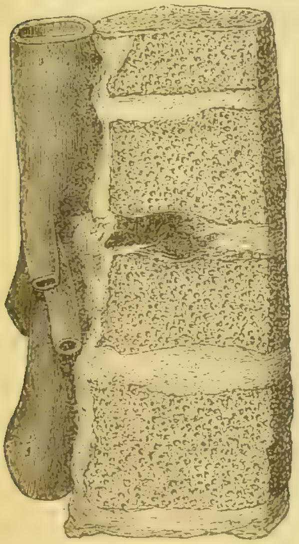

Fig. 467.—Erosion of Intervertebral Substance by a small Aneurism of Descending Aorta pressing backwards.

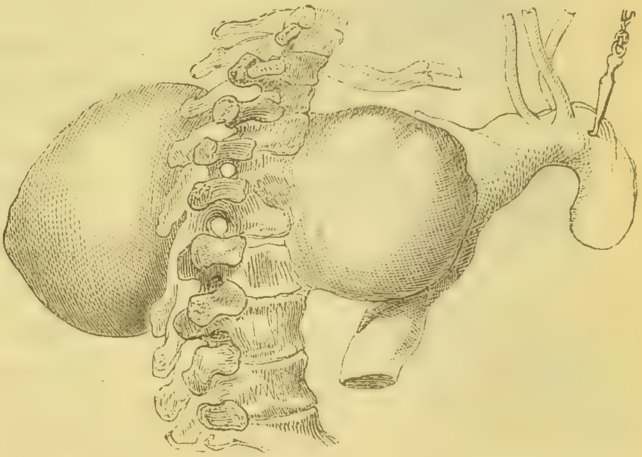

Fig. 468.—Aneurism of Descending Aorta, eroding and traversing Vertebræ.

The pressure-effects that need chiefly engage our attention, are :—1, Pain, 2, Dyspnœa ; 3, Dysphagia ; and 4, Œdema.

1. **Pain** is usually one of the earliest symptoms of intrathoracic aneurism, and is frequently of great value from a diagnostic point of view, as it is often most marked when the other symptoms are the least developed. It is generally more severe in sacculated than in fusiform aneurisms, and when the posterior rather than the anterior aspect of the vessel is the seat of disease. The pain is of two distinct kinds. The first kind is lancinating, intermittent, and neuralgic in its character, evidently dependent upon pressure on the spinal or sympathetic nerves. This pain is seated chiefly on the left side, and shoots up the side of the head and face, down the arm to the elbow, along the intercosto-humeral nerve, through the chest, or between the scapulæ. The second form of pain occurs usually at a later stage of the disease, is continuous, and of a boring, hot, or burning character. It seems to depend upon the perforation

of the tissues, more especially the bones, by the aneurismal tumour, and occurs chiefly on the right side of the chest (Fig. 468).

2. **Dyspnœa** is of very frequent occurrence in intrathoracic aneurism ; in all probability it is more uniformly met with than any other single symptom. It may arise from five distinct conditions, and its characters vary with its cause.

a. *From direct pressure on the trachea.* In these cases the dyspnœa is attended by much wheezing cough, and often by whistling sounds in the chest and tubular respiration, and by slow expansion of that cavity. There is usually expectoration of thick tenacious mucus.

β. *From direct pressure on a bronchus* (Fig. 469). In these cases there are wheezing cough, and some degree of expectoration, with perhaps diminished respiratory murmur in the side affected, and puerile respiration in the opposite lung, as has been pointed out by Stokes.

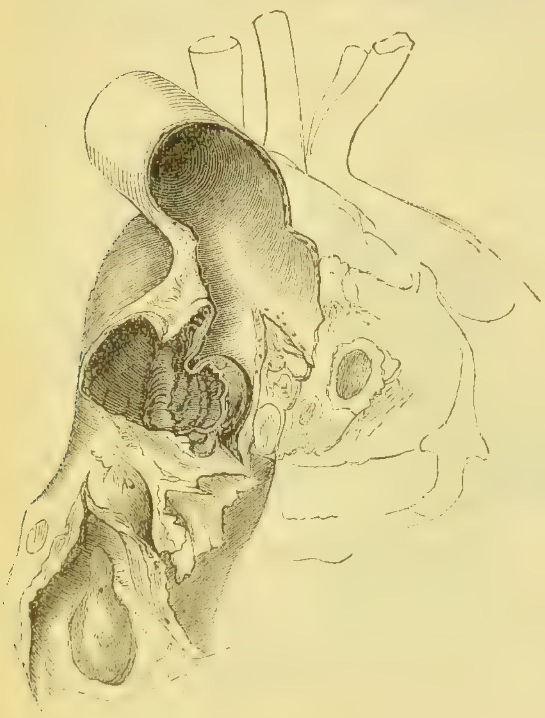

Fig. 469.—Aneurism of Arch of Aorta, of the size of an almond, springing from below left Subclavian Artery, and bursting into left Bronchus.

γ. *From pressure upon the lung.* In these cases the respiration is comparatively little interfered with, the spongy tissue of the lung accommodating itself and yielding to the pressure of the tumour. After a time the pulmonic tissue will become incorporated with the wall of the sac ; and then more serious difficulty in breathing, with hæmoptysis, will supervene.

δ. Dyspnœa is very commonly induced by *irritation, compression, or stretching of the left pneumogastric and recurrent laryngeal nerves,* by the pressure of the tumour. In these cases the muscles that are supplied by the left recurrent laryngeal nerve may be paralysed, so as to occasion attacks of intense difficulty of breathing. In many cases spasm occurs from irritation of the nerve before it is pressed on sufficiently to cause paralysis.

It is the *crico-arytenoideus posticus* muscle that is chiefly affected by the compression of the recurrent laryngeal. As its action is to open the glottis, its paralysis causes an impediment to the entrance of the air by the collapse of the left side of the rima glottidis—hence the dyspnœa and struggle for breathing under exertion. The voice becomes hoarse, croupy, or croaking ; the cough has a loud croupy or metallic sound, and is attended by the expectoration of thin frothy mucus. The laryngeal stridor often does not occur in ordinary respiration, but is produced under exertion, or on making the patient inspire fully and deeply. The laryngeal symptoms are sometimes so much more prominent than any of the other signs of intrathoracic aneurism, and so closely resemble chronic or even acute laryngitis, with impending asphyxia, that there are not a few cases on record in which Surgeons have performed tracheotomy, on the supposition that they had to do with cases of pure and uncomplicated laryngeal disease ; and in other instances this operation has been performed with a view of prolonging life, even when the dependence of the laryngeal spasm on aneurism of the aorta has been recognized.

Dr. George Johnson has made some important observations on the use of the laryngoscope in the diagnosis of the cause of dyspnœa in aortic aneurism. He says that, in cases in which the cause is pressure on the recurrent laryngeal nerve, the larynx is seen to be healthy, and the spasm may be seen to occur. If the pressure be sufficient to abolish the function of the nerve, unilateral paralysis will occur, which can be easily ascertained by laryngoscopic examination. The voice in such cases is weak and husky ; whereas, in cases in which the pressure is on the trachea, its character is unchanged. When a thoracic aneurism presses the trachea against the spine, the tracheal stridor and the voice-sound are heard with remarkable distinctness on applying the stethoscope over the upper dorsal vertebræ—the sound being conducted through the bones.

ϵ. Dyspnœa may be dependent on *compression of the pulmonary vein* by the aneurismal tumour. In cases of this kind there would be considerable lividity of surface, and signs of pulmonary congestion.

The dyspnœa of intrathoracic aneurism will often be sufficiently intense to occasion death. It may be mistaken for ordinary asthma ; but the diagnosis can usually be made, by observing that in aneurism the paroxysms of dyspnœa often come on in the day as well as at night, and are greatly increased by change of position as by placing the patient either upright or recumbent, the tumour thus shifting its point of pressure. It is, as Bellingham has pointed out, not influenced by atmospheric changes, and is generally associated with laryngeal stridor or spasm. When such symptoms as these are associated with pain and dysphagia, they point very strongly, even in the absence of all auscultatory signs, to the presence of an aneurismal tumour.

Aneurisms situated within the concavity or springing from the posterior parts of the aortic arch are those which, either directly by their pressure on the air-tubes or the pulmonary veins, or indirectly by the influence they exercise on the recurrent laryngeal nerve, are chiefly associated with dyspnœa.

3. **Dysphagia** is a symptom of sufficiently frequent occurrence in aneurisms of the thoracic aorta. It seldom occurs, however, in the earlier stages of the disease, or when the aneurism is small, and hence is of much less diagnostic value than dyspnœa. When, however, it is associated with that symptom, the combination becomes important ; as the co-existence of the two conditions clearly points to the compression of the œsophagus and the air-tubes by a tumour, which other diagnostic signs may prove to be an aneurism.

It is of importance to bear in mind that in some aneurisms, especially of the descending thoracic aorta, dysphagia may be one of the most marked signs. In such cases as these, stricture of the œsophagus has erroneously been supposed to exist, and the patient has even been treated by the introduction of bougies—an error of practice that has terminated fatally from perforation of the aneurismal sac, where it projected against the œsophagus.

The difficulty in deglutition in cases of compression of the œsophagus by aortic aneurism, is almost invariably referred to the episternal notch. The dysphagia is commonly associated with pain, or with the sensation of a cord drawn tightly around the body.

4. **Œdema,** with more or less lividity of the upper extremities and head and neck, occasionally though rarely occurs. It is generally most marked on the left side, and arises from the compression of the superior cava or the innominate veins by aneurisms springing from the fore or upper part of the arch.

Pulsation and **Tumour,** observable externally, are always absent in the early stages of intrathoracic aortic aneurism, and very frequently continue so to the end ; indeed, in aneurisms springing from the intrapericardial aorta or the concavity of the arch, death usually takes place, either by rupture into one of the serous cavities or the air-tube, or, by the exhaustion induced by dyspnœa, long before the aneurism has attained a sufficient size to be recognizable externally. There are, however, three portions of the thoracic aorta which, when affected by aneurism, yield external evidence by the existence of pulsation or tumour of the true nature of the disease. These are—1, the anterior aspect of the ascending aorta ; 2, the summit of the arch ; and 3, the posterior aspect of the descending aorta.

1. When the aneurism is situated *on the anterior aspect of the ascending aorta and commencement of the arch,* pulsation may be detected by pressure between the intercostal spaces on the right side of the sternum, and a thrill, as well as distinct impulse, may often be felt over that side of the chest, before any external tumour becomes visible ; thus simulating the beat of the heart, in addition and opposite to the seat of the true cardiac impulse. As the aneurism increases an external tumour appears, the wall of the chest becoming absorbed and perforated opposite the point of greatest impulse.

2. When an aneurism springs from *the summit of the arch,* a pulsating tumour appears at the root of the neck, behind or even above the margin of the sternum, most commonly towards the right side, and occasionally rises so high out of the thorax, and is so distinctly felt in the neck, as to run the risk of being confounded with aneurism of the brachio-cephalic or carotid artery (Fig. 474, p. 171). This error, which has frequently been committed, and which has led to operations on the arteries at the root of the neck, may usually be avoided, except in the case of the brachio-cephalic, by the impossibility of tracing with the finger the lower boundary of the tumour, and the existence of distinct dulness on percussion, and possibly of impulse or of auscultatory evidence of aneurism, below the level of the upper margin of the sternum or clavicle.

3. When aneurism springs from the *posterior wall of the descending aorta,* a pulsating tumour may gradually develop to one side of the spine or under the scapula, commonly on the left side ; and it may attain a great size, fully as large as a man's head, before the patient is destroyed by the rupture of the tumour externally.

TREATMENT.—In the great majority of aneurisms of the thoracic aorta surgical interference is impossible, and our sole reliance must be placed on rest, diet, and the administration of iodide of potassium (see p. 119).

Surgical Treatment of Aneurism of the Aortic Arch.—The idea of treating aneurism of the aortic arch by ligature of one or two of the main arteries at the root of the neck, originated in the results of an operation performed by Christopher Heath in 1865 for the cure of a supposed innominate aneurism by the simultaneous ligature of the right carotid and subclavian arteries. The patient, a woman of intemperate habits, survived the operation for four years, appearing for a time to have been benefited by it. On her death it was found that the aneurism was not one of the innominate but of the ascending aorta, and that it had been practically cured by or after the operation. Dr. Cockle about the same time was engaged in a series of observations on the spontaneous consolidation of aneurisms of the aortic arch ; he found that in some of these cases the *left* carotid artery had become occluded, and he inferred from this that ligature of that vessel might be of use in the treatment of certain forms of aneurism of the arch. This suggestion was acted on by C. Heath, who, in 1872, tied the left carotid artery in a patient of Dr. Cockle's affected with aneurism of the ascending and transverse portions of the arch. The patient was benefited by the operation. Barwell has operated in two cases, in one with advantage. In the other, in which the left subclavian was also tied, the patient died, apparently uninfluenced for good or ill by the operation. Heath's second case of ligature of the left carotid proved fatal by syncope. In all, the operation appears to have been done 13 times (Ashurst)—in six cases with more or less benefit. In at least four of these cases the artery was ligatured on the supposition that the aneurism was situated at the root of the carotid, when, in reality, it occupied the arch. Barwell states that, in those aneurisms which spring from the aorta beyond the left carotid, ligature of this vessel will do more harm than good, and that the operation should be confined to those in which the tumour appears on the left side, but not far from the median line, and rises into the episternal notch or under the left sterno-mastoid.

The **Simultaneous Ligature of the Right Carotid and Right Subclavian Arteries** for aneurism of the aortic arch has, according to Barwell, been done in three cases only for aneurism diagnosed as aortic before the operation. In some other cases, as the one referred to above, diagnosed erroneously as innominate, but proving in reality to be aortic aneurism, it has also been done. In the three cases of recognized aortic aneurism the operations were done by Barwell, Lediard, and Wyeth. In all, the ox-aorta ligature was used, and the patients lived 15 months, 8½ months, and one year respectively after the operation (Barwell).

The ligature of one or more of the main arteries at the root of the neck for the cure of aneurism of the aortic arch involves a new principle in the treatment of that disease ; one that differs in all respects from that in which the cure of an ordinary external aneurism is effected. By whatever way the Surgeon acts, whether by the proximal or the distal ligature, by compression with instrument or finger, he seeks one common result, viz., the arrest or retardation of the circulation through the sac so as to facilitate the deposit of laminated fibrin or firm clot. He usually acts directly upon the artery that is the seat of the disease, and in all cases of the Hunterian operation, or of arterial compression, the supply of blood sent into the sac is most materially diminished, if not altogether arrested. But in the treatment of aortic aneurisms by ligature of the left carotid only, or by that of the right carotid at its root, and of the right subclavian in the third part of its course, he does not in any way diminish or retard the flow of blood through the aorta or lessen the quantity sent into the aneurismal sac. Moreover, the ligature of the artery by interposing abnormal resistance in the circulation would cause increased tension in the sac as well as in the arteries generally, until the dilatation of the anastomosing vessels had relieved the obstruction. Thus the very reverse of what happens in the Hunterian or ordinary distal operation, takes place when one or more of the primary branches of the aortic arch is tied. And if a cure of an aneurism in this situation be thus effected, it must be on a new principle, different from any that has yet guided the Surgeon in the treatment of this disease.

That some benefit appears to have followed these operations in a few of the cases is undoubted ; but how much of this may be fairly attributed to the direct influence of the operation appears to me to be very uncertain. For it cannot be doubted that the confinement to bed after the operation, and the more careful and regulated life that would be led by those who had been subjected to so serious a procedure, must exercise a very directly beneficial influence upon any internal aneurism ; and it may fairly be a question whether a patient, subjected to an operation that would require confinement to bed or at least absolute rest for several weeks and subsequently necessitate a quiet and carefully regulated life, would not derive as much benefit as the patients in whose necks large arteries have been tied for the cure of aortic or even of most innominate aneurisms have done.

The necessity for hesitation in the adoption of these operations for the cure of aortic aneurism appears to me to be strengthened by the acknowledged difficulty, in many cases, in making a correct diagnosis of the exact seat of the aneurism, whether it be innominate or aortic, or both, or, if aortic, from what part of the arch it springs ; and also in determining with absolute certainty whether a given intrathoracic tumour be an aneurism or not.

The immediate danger of these operations, whether done for aortic or innominate aneurism, is also very considerable. A very large proportion of the patients so operated on died within a fortnight, and in some cases death resulted immediately or within a few hours rom the disturbance of the circulation through the brain by the ligature of one of the greater arteries springing from the arch.

Another fact of much importance that cannot be ignored in considering the advisability of subjecting a patient with supposed aortic aneurism to the operation of ligature of the carotid and subclavian arteries is the undoubted very slow progress and prolonged duration of many of these aneurisms, and the possibility of a spontaneous cure in some. Patients with aortic aneurisms frequently live for several years after the disease has been recognized. Under proper constitutional treatment the severity of the symptoms may be greatly mitigated, and in all probability the chances of cure would be about equal under the two modes of treatment—the strictly surgical and the medical—whilst speedy or sudden death would be more likely to occur to those subjected to the operation.

Attempts to obtain consolidation of the tumour by the introduction of coils of iron wire, catgut, or horsehair, have not as yet been attended by any marked benefit to the patient (see p. 152).

The mode of treatment which has been more frequently adopted than any other is **galvano-puncture** ; and it seems probable that in well-selected cases this may be productive of good, or even occasionally lead to a cure. In 27 cases of aortic aneurism thus treated, which have been collected by John Duncan, 5 were cured, 10 relieved, 9 unrelieved, and 3 died. Experience has shown that with well insulated needles and a suitable battery there is scarcely any danger to life, and that the operation, even when it does no good, does no harm. It has been applied in all stages of the disease, from the time when the tumour becomes sufficiently superficial to allow the safe introduction of the needles, to the time when it has perforated the chest-wall, and is on the point of bursting. In one of John Duncan's cases, the life of the patient was undoubtedly prolonged for nearly three months after the time at which, if left to itself, the aneurism would have burst externally. The cases best suited for galvano-puncture, and in which even a cure may occasionally be hoped for, are those in which the tumour is of slow growth, has not yet perforated the chest-wall, and in which it can be diagnosed as sacculated and communicating with the aorta by a comparatively small opening. It is important also that the patient's health should not be too much broken by suffering or visceral disease. When the tumour projects through the parietes of the thorax, forming a secondary sac outside, the prospect of cure is infinitesimally small ; but even then, progress may be delayed, and much relief given to the patient. If the tumour have become diffused, as may occur when it points in the back, galvano-puncture can only do harm by increasing the tendency to inflammation and suppuration already existing. For the details of the operation, see page 149.

There is one point in the treatment of some forms of aortic aneurism, that falls more within the province of the Surgeon, and on which his opinion may be sought. I mean the advisability of **opening the windpipe,** to relieve the patient from the distress occasioned by the laryngeal spasm or paralysis that commonly attends many of these cases. The decision of this question is always an anxious one ; for it must be borne in mind that, as the disease that occasions the spasm of the larynx is necessarily and inevitably fatal, the operation can be expected to give only temporary relief, and perhaps but a brief prolongation of life.

In determining this question, the Surgeon must bear in mind that simple laryngeal spasm is rarely, if ever, the direct cause of death in aortic aneurism ; that, alhough the patient may suffer greatly from this complication, he does *not* die of it ; but that the ultimate cause of death is usually intrathoracic pressure, rupture of the sac internally or externally, or exhaustion. The operation, therefore, would be justifiable in those cases only in which it could be determined that the spasmodic dyspnœa was purely laryngeal, and was not dependent on compression of the air-passages within the chest by the aneurismal tumour, but simply on the irritation produced by the implication of the left recurrent laryngeal nerve. Such cases are very rare, and necessarily most difficult of accurate diagnosis. As the Surgeon will usually get the credit of having killed the patient if he be induced to perform the operation, and the relief be not immediate and great, I would advise him not to operate unless the diagnosis be most clear, or in circumstances of imminent death from laryngeal spasm, with the view of affording immediate, even if it be only temporary, relief. If any operation be done, it should certainly be laryngotomy, and not tracheotomy.

ANEURISM OF THE INNOMINATE ARTERY.

Aneurisms of this artery are very frequently accompanied by dilatation or actual aneurism of the aorta. Innominate aneurisms may be either of the tubular or the sacculated kind, and usually give rise to a train of serious and dangerous symptoms, from their pressure upon important parts in their neighbourhood. Indeed, a glance at the relations of this artery will show the important effects that must be produced by the pressure of a tumour springing from it. Before it lies the left innominate vein, to the outer side are the lower cervical cardiac branch of the pneumogastric, the right innominate vein, the right pneumogastric and the pleura ; behind it and to its inner side is the trachea. An aneurismal tumour of the innominate artery may extend backwards so as to come into relation with the œsophagus, and upwards so as to press on the right recurrent laryngeal nerve.

SYMPTOMS.—The general symptoms of an aneurism of this artery are the existence of a pulsating tumour of a globular shape behind the right sterno-clavicular articulation, attended with pain, and perhaps œdema of the right side of the face and right arm, with some difficulty in respiration, laryngeal cough, and dysphagia. The tumour is usually soft and compressible, filling up more or less completely the hollow above the sternum, and even rising as high in the neck as the lower margin of the cricoid cartilage ; it pushes forwards, first the sternal, and afterwards the clavicular portion of the sterno-mastoid muscle, and has occasionally been seen to extend into the posterior inferior triangle of the neck ; and, indeed, is generally most distinctly defined towards its brachial aspect. In some cases no tumour rises into the neck, but the sternum, clavicle, and costal cartilage of the first rib, are found to be considerably pushed forwards beyond their natural level. In the space around the right sterno-clavicular articulation, and about the upper part of the sternum, there will be dulness on percussion, and marked pulsation is often felt in the first intercostal space. In very many instances there is no bruit, but merely a strong impulse with the heart's sounds, as distinct as in the cardiac region, or even more so ; but in other cases there may be every variety of bruit.

Pressure-Effects.—The most important symptoms are occasioned perhaps by the pressure-effects of the tumour upon the neighbouring parts, affecting the pulse, the venous circulation, the nerves, respiration, and deglutition.

The **Pulse** is usually influenced, being much smaller and feebler in the radial artery of the affected than of the sound side, and in some instances being completely arrested ; owing, doubtless, to pressure on or occlusion of the subclavian. The pulsation in the right carotid and its branches is also frequently much less powerful than in the opposite vessel. These signs commonly occur before any external tumour is seen or can be felt, and hence constitute an important element in the early diagnosis of the disease.

Enlargement of the Superficial Veins of the neck and right upper extremity is of frequent occurrence, the external jugular being the vessel that is usually first evidently dilated ; at a more advanced period the superficial subcutaneous veins of the upper part of the right side of the chest often become tortuous and form a dense plexus in this situation, while many anastomose with the cephalic and thoracic veins above, and the superficial epigastric below. As the pressure increases, œdema commences in the right eyelids and hand, and may speedily extend to the whole of the head, face, and arm, which become hard and brawny in consequence of serous infiltration. In one instance I have seen the left arm become suddenly œdematous, the left innominate vein being pressed upon. In these cases the eyes become staring and prominent, and the lips, nose, and other features livid and turgid with blood, as well as œdematous, so as to greatly alter the expression of the countenance.

Pain of a dull aching character is experienced in the situation of the tumour, from the compression of the neighbouring structures. But in the later stages of the disease the patient often experiences sharp shooting pains, resembling those of rheumatism or neuralgia, in the arm and the side of the head and face, arising from pressure upon, and irritation of, nerves of the cervical and brachial plexuses. Taking the course of the ascending and descending filaments of the cervical plexus, the pain shoots up the side of the head and neck, and over the shoulder and upper part of the chest; or, from pressure upon the brachial plexus, it radiates down the hand and arm, being usually especially severe about the elbow and fingers. The muscular power of the right arm also commonly becomes impaired. Persistent dilatation of the vessels, with sweating of one side of the face, occasionally occurs from pressure on the sympathetic.

Dyspnœa is of very common occurrence, and of very varying degrees of intensity, from slight difficulty in breathing up to fatal asphyxia. It may proceed either from compression of the recurrent nerve, or from pressure on the trachea. When it depends on the former condition, the voice is hoarse, husky, or whispering; and there is a dry, croupy, and paroxysmal cough, usually accompanied by expectoration of thin frothy mucus. In these cases, after death, the right recurrent nerve will be found to be stretched out and greatly elongated by the pressure of the tumour (Fig. 470). Compression of the trachea, which becomes flattened and curved over to the left side by the protrusion of the tumour, is a common cause of dyspnœa, and is not unfrequently associated with pressure on the recurrent nerve.

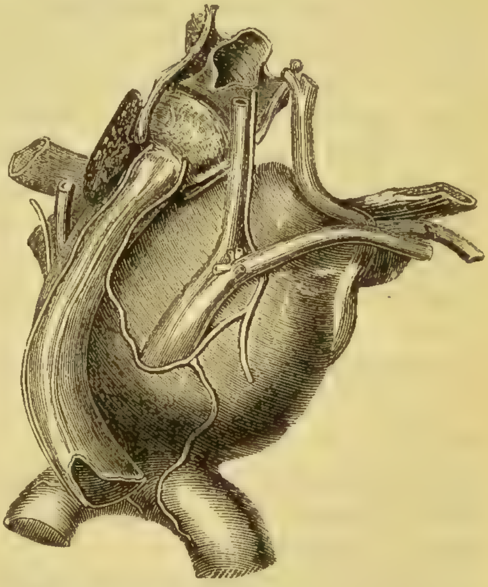

Fig. 470.—Aneurism of the Innominate Artery compressing and stretching the Recurrent Laryngeal Nerve, and pushing the Trachea to the Left Side. (Back View.)

The laryngeal dyspnœa in these cases is analogous to that which occurs in aortic aneurisms (p. 156); the only difference being, that in one case it is due to pressure upon and paralysis of the muscles supplied by the right, in the other, of those to which the left recurrent nerve is distributed. It is the paralysis of the crico-arytenoideus posticus muscle that is so especially distressing and dangerous; for by its paralysis the corresponding side of the glottis is closed. More rarely by far, the right bronchus is compressed by the extension of the tumour downwards.

Dysphagia is of sufficiently frequent occurrence, and varies from slight uneasiness in deglutition to an impossibility of swallowing anything except fluids. I have never seen it occur without having been preceded by dyspnœa; and, in every instance that has fallen under my observation, it has been associated with laryngeal dyspnœa. The coincidence of these two symptoms is readily explained by the anatomy of the parts; the recurrent nerve, lying between the sac and œsophagus, must suffer compression before the mucous canal can be interfered with.

Prognosis.—The prognosis of brachio-cephalic aneurism is in the highest degree unfavourable, though the disease frequently does not run a rapid course. If it extend upwards and outwards, the tumour may acquire a very large size before any very important organ or part is implicated; but if it press backwards and inwards, it may prove fatal at an early period. I know of only one case of spontaneous cure (reported by J. Ogle), and but few instances in which rupture of the sac has taken place. The most frequent cause of death is asphyxia, from spasmodic closure or paralysis of the larynx induced by pressure on the recurrent nerve; or from pressure on the trachea.

Diagnosis.—The diagnosis of innominate aneurism is usually sufficiently easy, if attention be paid to the symptoms that have just been detailed. But at times the difficulty is so great as to baffle the most sagacious Physicians and most experienced Surgeons; that which has during life been considered to be an aneurism of the innominate artery, having, after death, proved to be one of the summit of the aortic arch rising up into the root of the neck behind the right sterno-mastoid, or overlapping the brachio-cephalic trunk. The task of overcoming this difficulty in diagnosis must be left to the skill of the Surgeon. But it is impossible to over-estimate its importance, when the question of ligaturing the arteries at the root of the neck for a supposed innominate aneurism is contemplated; for, in at least three cases in which this operation has been done, the arch of the aorta has been found to be the seat of disease, the innominate in two of the cases being unaffected by aneurism. I am acquainted also with a fourth case, in which the operation was commenced, but was abandoned, as the subclavian could not be reached; the patient dying a few days afterwards, the aneurism was found to be aortic, rising up into the root of the neck, the innominate being sound.

Treatment.—There are several instances on record in which a properly conducted course of constitutional treatment has cured the patient; thus a case of Luke's was permanently cured by small and repeated bleedings, conjoined with the administration of digitalis. In connection with such treatment, distal pressure may be employed, as in a case that derived benefit from this plan in Syme's hands.

In aneurism of the innominate, the vessel is so short, and the sac so situated, that it is impossible to attempt to apply a ligature on the cardiac side of the tumour. What resource, then, does surgery offer in these cases beyond the employment of constitutional and dietetic means? It may be answered to this, that, if these measures fail in arresting the disease, our choice must lie between two alternatives; leaving the patient to his fate, or having recourse to the application of the ligature on the distal side of the tumour. On looking at the innominate artery with reference to the distal operation, we are struck by two peculiarities in the vessel, which must necessarily modify to a considerable extent not only the seat of the operation, but the principle on which it is conducted. The first peculiarity to which I allude is the shortness of the trunk, which makes it impossible to apply the ligature to the vessel itself, but renders it necessary to deligate one or both of its terminal branches. The other peculiarity is, that in no circumstances can these vessels be so ligatured as to arrest the whole of the blood sent into the artery: for.

although the circulation through the carotid may be entirely stopped, yet it is impossible, from the seat and extent of the disease, to tie the subclavian at any point except beyond the scaleni ; hence that blood which is destined for the supply of the branches of this vessel—the vertebral, the thyroid axis, the internal mammary, and the first intercostal—must continue to pass through the sac. Three distinct modifications of the distal operation have been proposed and resorted to for the cure of aneurisms in this situation : 1. Ligature of the Subclavian alone : 2. Ligature of the Carotid alone ; and 3. Ligature of Both vessels with an interval of greater or less extent.

1. **Ligature of the Subclavian only** (Fig. 471) has been practised by Dupuytren, Wardrop, Laugier, and Broca. Dupuytren's and Laugier's cases were soon fatal, and Broca's experienced no relief and died in six months. In Wardrop's case the tumour diminished and the patient survived for two years. This partial success may fairly be attributed in a great measure to the accident of the carotid having been occluded by the disease. The results of this practice have certainly not been sufficiently favourable to justify the Surgeon in repeating an attempt of this kind, opposed as it is to the known principles on which the distal operation effects a cure.* For, supposing as we may safely do, with Wardrop, that only one-third of the blood that is sent into the innominate finds its way through the extra-scalenal portion of the subclavian, the remainder being destined for its branches and the carotid in equal proportions, what fact can be adduced or principle laid down from which we can expect to obtain the cure of an aneurism in close proximity to the heart, by cutting off for a short time only so small a proportion as one-third of the supply of blood sent into it? As soon as the collateral vessels

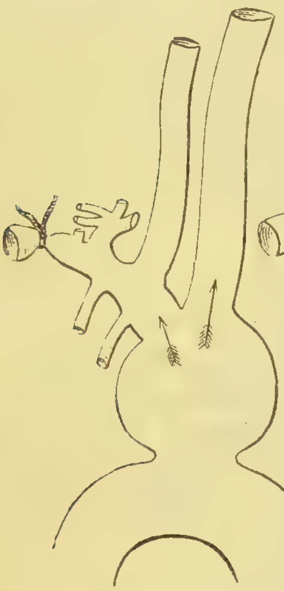
Fig. 471.—Brachio-cephalic Aneurism : Ligature of the Subclavian only.

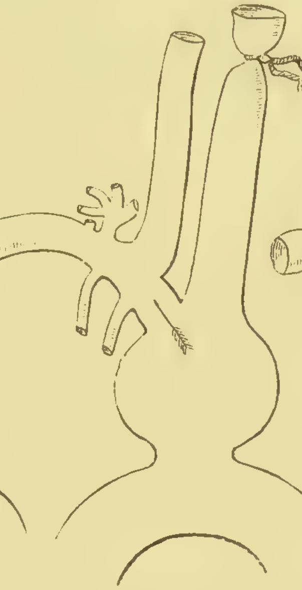
Fig. 472.—Brachio-cephalic Aneurism : Ligature of the Carotid only.

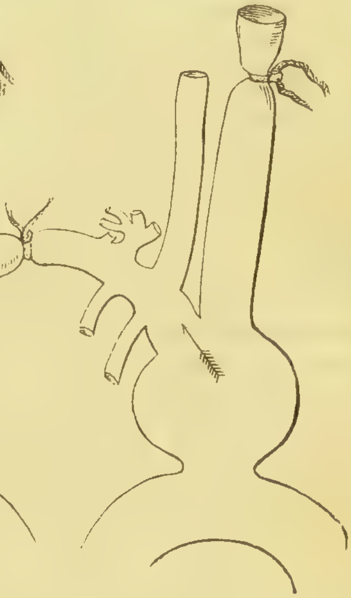
Fig. 473.—Brachio-cephalic Aneurism : Ligature of the Subclavian and Carotid.

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* The Tables of Operations for Innominate Aneurism given in former editions have not been reproduced, as the number of these operations has so greatly increased of late years as to make it impossible to record all without occupying too much space.

have dilated the flow of blood through the artery will be the same as before the operation, as the supply of blood to the upper limb is maintained by means of the anastomoses of the branches of the first and second part of the subclavian with those of the axillary artery.

2. **Ligature of the Carotid only** (Fig. 472, p. 165) for innominate aneurism was first performed by Evans in 1828. The tumour diminished for a few days after the operation, but at the end of seven days inflammation of the sac set in, followed by obliteration of the arteries of the right arm and the branches of the carotid. At the end of a year a tumour still existed, with constant pulsation. Next year the sac suppurated, and discharged much pus. Since that time the operation has been repeated by Mott, Aston Key, Fergusson, Hutchinson, Pirogoff, and many others, amounting in all, according to Holmes, to nineteen cases. In only one case, that operated on by Evans, does the disease appear to have been materially relieved ; and in that instance the good effects can scarcely be attributed to the operation, but must rather be looked upon as the result of suppuration of the sac and consequent obliteration of the arteries of the arm and head of the affected side. Key's patient died in consequence of the left carotid becoming occluded and the brain being deprived of its proper supply of blood ; and in several other cases death is referred to hemiplegia and other cerebral diseases.

3. The **Carotid and Subclavian Arteries** (Fig. 473, p. 165) were tied simultaneously for the relief of innominate aneurism for the first time by Rossi in 1843, but there is some doubt as to the part of the artery to which the ligature was applied. Since that time the operation has been performed by Durham, Holmes, McCarthy, Weir, Lane, Pollock, Stimson, Little, Langley Browne, Barwell, Bergmann, Heath, and others. According to Holmes the total number of cases up to 1882 amounted to twenty, to which Bergmann's case must be added. In seven cases, marked improvement followed the operation. Stimson's patient survived the operation twenty-one months. Four months after it he was suddenly attacked by left hemiplegia and aphasia, after which the tumour diminished in size rapidly. He partially recovered from the paralysis. After death the third part of the subclavian and the carotid were found to be obliterated ; the sac of the aneurism was about the size of a hen's egg, and communicated with the subclavian, all the branches of which, except the internal mammary (which could not be found) were patent. Little's case lived three and a half years, dying at last of pleurisy. The aneurism was practically cured, but a channel existed through it to the subclavian. Of Barwell's four cases, one died from the anæsthetic, and three were successful. One died three months after the operation of bronchitis, and the second died two years after also of bronchitis ; in both of these the disease was practically cured. The third remained well up to the last report. In Browne's, Bergmann's and Heath's cases the improvement continued up to the last report. Of the fatal cases, four died from rupture of the sac, one from hæmorrhage from the ligatured arteries, one from shock, one from hæmorrhage from the sac, one from exhaustion, one from asphyxia, one from the anæsthetic, two from the unrelieved progress of the aneurism, and in two the cause of death was doubtful. The operation was attempted in another case by Chevers, but the subclavian vein was wounded, and the patient died in two hours.

The carotid and subclavian have also been tied consecutively at intervals varying from two years to one month, in six cases, by Fearn, Wickham, Malgaigne, Mott, Bickersteth, and Adams and Treves. In all cases the carotid was tied first. In Fearn's case two years elapsed between the operations, and the patient died four months after the subclavian was tied, of pleurisy. The aneurism was found to be consolidated, with the exception of a channel leading to the subclavian. In Wickham's case relief followed the ligature of the carotid, but symptoms soon returned, and the subclavian was tied about six weeks afterwards, but without effect, the patient dying in two and a-half months from rupture of the sac. In Mott's case a practical cure resulted, the patient dying of phthisis three years after the second operation. In Adams and Treves's case the aneurism was consolidated, but death took place 108 days after the second operation from rupture of the sac of an aortic aneurism. In the remaining cases no benefit was derived from the operation.

A *résumé* of the cases of aneurism of the innominate, in which the operation of ligaturing one or both arteries beyond the sac has been performed, having thus been given, the question arises whether these operations, or any of them, should retain a place in surgery. This question may be examined from two points of view: 1. As to the principle on which these operations are performed; and 2. As to their results in practice. For the success of the distal operation it is requisite that there be no branch given off, either from the sac or between it and the ligature; or that the current of blood through the sac be at least so far diminished as to admit of the deposit of laminated fibrin in sufficient quantity to fill it up, by a process similar to that which takes place in a case of aneurism treated by the Hunterian method. In order that this may be accomplished, it is certainly necessary that the greater portion of the blood passing through the sac be arrested; for if the current that is still kept up be too free, the tumour will continue to increase, as I have seen happen in cases of inguinal aneurism in which the femoral artery was ligatured below the epigastric and the circumflex ilii, the current through which was sufficient to feed the sac in such way that a cure could not be accomplished. If, therefore, but one of the vessels leading from the brachio-cephalic, as the subclavian beyond the scaleni, be tied, and but a third of the blood circulating through the main artery be arrested, are we justified in hoping that the circulation through the sac will be so influenced by the diversion of this small quantity, that the remaining two-thirds of the blood, which will still pass through for the supply of the carotid and the branches of the subclavian, will gradually deposit those fibrinous laminæ by which obliteration of the tumour is to be effected? Should we not rather expect that the larger current will be too powerful to allow the formation of these layers, and will continue to distend the sac in such a way as to prevent its contraction? Surely, if the comparatively small and feeble streams of blood, that pass through the epigastric and circumflex ilii, are sufficient to interfere with the cure of an inguinal aneurism after the distal ligature of the femoral, the strong current that sweeps through the carotid and the large branches springing from the subclavian, with the full force derived from close proximity to the heart, will most probably be sufficient to prevent all lamination in an aneurism of the innominate. That the arrest of the circulation through one of these vessels only is not sufficient materially to influence the growth of the aneurism, is evident likewise from what is not unfrequently observed after death in cases of this kind—one or other of the vessels being found compressed and obliterated by the pressure of the sac, or plugged by fibrin, and yet no alteration in the tumour resulting. These cases, which are tolerably numerous, would of themselves have been sufficient to prove that something more than this amount of obstruction is required, in order to effect proper stratification of fibrin in the sac; and if we turn to the results of the twenty-three cases in which either the carotid or the subclavian has been ligatured, we shall find that in one case only, that operated on by Evans of Belper, has a cure been effected; and in this instance how was it accomplished? According to the principle on which it was attempted to be established? Certainly not; but, as will be seen by attention to the details of the case, and as was pointed out by Guthrie, by the accidental setting up of inflammation, which extended to the sac, and thus obliterated it.

In the case (that of Mrs. Denmark) in which Wardrop tied the subclavian for the cure of aneurism of the brachio-cephalic, there is some reason to doubt whether the arrest of the progress of the tumour was owing to the ligature of the subclavian artery, or whether it was not much influenced by the obstruction which existed in the carotid for nine days after the operation, during which time so abundant a deposit of laminated fibrin might have occurred as to arrest the progress of the disease for some length of time. In this case also, Guthrie thought it probable that the inflammation of the tumour might have led to its obliteration.

From a careful consideration of all the circumstances of the cases in which ligature of one vessel only, either subclavian or carotid, has been employed for brachio-cephalic aneurism, we are, I think, fully justified in concluding that in sixteen of the cases the fatal result was accelerated, occurring as a consequence of the ligature of the vessel; in three the progress of the disease was not materially interfered with; in two it was arrested, the patients living for twenty months and two years respectively; in one the result was uncertain, and only in one case the disease was cured. The improvement in two of the cases was the result of accidental circumstances, which were unexpected, and unconnected in any way with the principles on which the operation was undertaken. These results would not, in my opinion, justify any Surgeon in again making an attempt to cure an innominate aneurism by the ligature of either the subclavian or the carotid artery alone, the patient having been directly killed by the operation in two-thirds of the cases. Of the remaining third, in one-half the patients recovered from the operation, but the disease ran its course as if no such procedure had been adopted; and in the remaining slender percentage of cases the improvement that took place in two, and the cure in the one solitary instance, were due to accidental circumstances unconnected with the operation, and which consequently might have developed equally if none had been performed.

We have yet to consider the operation in which both arteries are ligatured. This double operation may either be performed *with an interval between the application of the two ligatures*, sufficient for the establishment of collateral circulation; or the two vessels may be ligatured simultaneously. Of six cases in which an interval intervened between the two operations the tumour seems to have been practically cured in three, in two cases no relief was obtained, and one died directly from the operation. In twenty-one cases in which the vessels were ligatured simultaneously, death took place directly from the operation in four; the disease was unrelieved, and terminated fatally in eight; in two the cause of death is somewhat uncertain, and in seven great benefit or a practical cure resulted. It is interesting to note that the later cases have been the most successful, and it is reasonable to hope that this is due to modern improvements in the methods of tying arteries and dressing wounds. The cases, however, are not yet sufficiently numerous or free from modifying circumstances to enable us to draw any certain inference from them; we must therefore revert to the principle on which this operation should be undertaken. This will differ materially, according as the two arteries are ligatured simultaneously, or with a sufficient interval for the re-establishment of collateral circulation.

If an interval of two years, as in the first case, or even of two-and-a-half months, as in the second instance, be allowed to elapse between the ligature of the carotid and that of the subclavian, the operation reduces itself essentially to that of the ligature of a single artery, which, as has already been shown, is insufficient to induce those changes in the sac that are necessary for the accomplishment of a cure. If the patient survive the effect of the ligature of the carotid for a few weeks, sufficient time will have been afforded for the proximal end of the subclavian, the vertebral artery, and the thyroid axis to undergo great development—the collateral circulation being carried on by them and not by the left carotid; so that, by the time that the subclavian comes to be ligatured beyond the scaleni, the sac will still continue to be traversed by a current of blood for the supply of the branches of the subclavian, dilated beyond their normal size in consequence of the task of supplying the right side of the neck, face, head, and brain being principally thrown upon them. This current through the proximal end of the subclavian, increased as it will have been by the whole of that blood which is destined to supply the place of that which should pass by the carotid, will place the sac in nearly the same condition as it was before the ligature; and will consequently, for the reason that has already been given, be too powerful for a cure to take place in the course of its stream.

It now only remains for us to consider the *simultaneous* ligature of both vessels. In reasoning upon the simultaneous ligature of the two vessels, we must consider two points: 1. In what condition do we place the sac? 2. Is the danger of the patient much increased?

So far as the *sac* is concerned, it is impossible to place it in a better condition for the deposit of laminated fibrin; two-thirds of the blood flowing through it being arrested, and only that traversing it which is destined for the supply of the branches of the subclavian. It is by no means improbable that even this stream may be too large and forcible to allow the process of occlusion to take place, yet it is impossible further to diminish it; and if the aneurism be sacculated, and project from one side of the innominate artery, particularly to its internal or mesial aspect, it is by no means impossible that it may be sufficiently removed from the stream to allow consolidation of its contents.

Does it add to the danger of the patient to ligature these two vessels simultaneously rather than separately? I think not. If the risk of a double operation is to be incurred, I cannot think that it would be positively increased by the two being performed at once, instead of with an interval between them; the whole of the vessels that serve to maintain the collateral circulation in the head and upper extremity being left without interference. And the result that has followed the limited number of these operations confirms this opinion, for we find that the patients recovered from the operations in fifteen out of twenty-one cases.

The result of these fifteen cases, so far as the aneurism itself was concerned, was not altogether unsatisfactory when the otherwise hopeless nature of the disease is taken into consideration. In seven the patient derived great and unmistakeable benefit, and in the remaining eight there is no reason to believe that the operation hastened death. So far, then, as actual results go, it is evident that the chances are decidedly against the patient's deriving any benefit from the operation, and at the same time it must not be forgotten that aneurisms of the innominate artery have been cured by palliative and constitutional treatment. It does not seem justifiable, therefore, to resort to the distal ligature till these means have had a fair trial. If, however, rest, diet, and medical treatment fail to arrest the progress of the disease, the amount of success obtained from operative interference has been quite sufficient to encourage a repetition of it in well-selected cases.

ANEURISM OF THE CAROTID ARTERY.

Aneurismal Varix of the Carotid Artery and of the Jugular Vein as the result of punctures and stabs in the neck, has been met with in a sufficient number of instances to establish the signs and treatment of such a condition ; and an instance is related by Mackmurdo, in which a communication was established between these vessels as the result of disease ; but I am not acquainted with any case of *Varicose Aneurism* of these vessels having been recorded. The *Signs* of aneurismal varix in this situation present nothing peculiar ; and the *Treatment* must be entirely of a hygienic character, no operative interference being likely to be attended by any but a fatal result. It is the more desirable not to interfere in these cases, as the disease does not appear to shorten life.

Spontaneous Aneurism of the Carotid is not of very unfrequent occurrence : in Crisp's table of 551 aneurisms, 25 were of the carotid ; and it ranks in order of frequency between those of the abdominal aorta and of the subclavian. It occurs more frequently in the female than any other external aneurism ; thus, of the 25 cases alluded to, 12 were in women. This is owing probably to its seldom being the result of violence, but generally arising from disease of the coats of the vessel. In Holmes's table of 337 aneurisms, 11 were of the common carotid, 10 being spontaneous, and 1 traumatic. Three of the former were in women. This aneurism is also remarkable as occurring at earlier ages than most others ; thus, Hodgson has seen it in a girl of ten ; Sykes, of Philadelphia, in one of eighteen ; C. Heath in a woman aged twenty-three (external carotid), who was suffering from extensive disease of the cardiac valves. The right carotid is much more commonly affected than the left, and the upper portion of the vessel than the lower ; indeed, the bifurcation is the most common seat of aneurismal dilatation. The root of the right carotid not uncommonly is dilated ; but I have never seen or heard of a case in which the left carotid, before emerging from the chest, has been affected.

SYMPTOMS.—A carotid aneurism in the early stage presents itself as a small, ovoid, smooth tumour, with distinct pulsation and bruit, and a well-circumscribed outline. It is commonly soft and compressible, diminishing in size on pressure, and expanding again with the usual aneurismal dilatation. As it increases in size, it becomes more solid, occasions shooting pains in the head and neck, and, by its pressure on the pharynx, œsophagus, and larynx, produces difficulty in deglutition and respiration: sometimes the salivary glands are much irritated. After a time, the cerebral circulation becomes interfered with, giving rise to giddiness, impaired vision of the corresponding eye, noises in ear, and a tendency to stupor. These symptoms may be owing to compression of the jugular, to difficulty in the transmission of the blood through the tumour, or to irritation of the cervical ganglia of the sympathetic. The size that these aneurisms may attain varies greatly: usually they are confined to the space under the angle of the jaw, but not unfrequently they occupy the greater part of the side of the neck. If they be allowed to increase without interference, death may happen, either by rupture externally, or into the pharynx or œsophagus; by asphyxia, from pressure on the larynx or recurrent nerve; or by starvation from compression of the œsophagus.

Aneurisms of the carotid are usually of slow growth, and may sometimes exist for a considerable number of years without giving rise to any special inconvenience; this is more particularly the case when they are seated at the bifurcation of the artery. I have, however, seen a spontaneous aneurism in this situation attain the size of a small orange in a few weeks. When at the root of the neck, they are more likely to be attended by injurious pressure effects at an early period.

Diagnosis.—The diagnosis of carotid aneurism is without doubt more difficult than that of any other form of external aneurism: the best proof that this is so, may be found in the fact that, of the cases in which the carotid artery has been ligatured for supposed aneurism of its branches, in several instances no such disease existed—solid cysts, or other tumours of the neck having been mistaken for aneurism, and this by Surgeons of great and acknowledged repute.

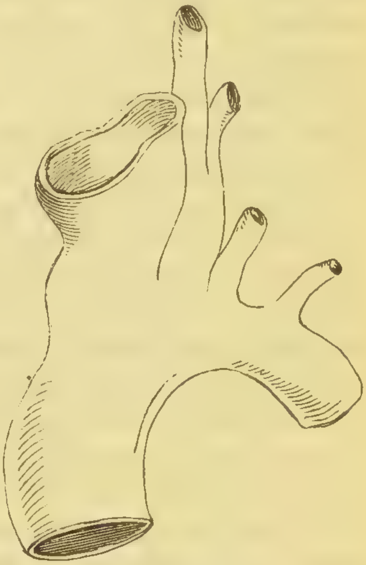

Fig. 474.—Aneurism of the Summit of the Arch of the Aorta, simulating Carotid Aneurism.

The diagnosis of aneurism of the lower part of the carotid from *similar disease of other arteries* at the root of the neck, as of the subclavian, vertebral, and brachio-cephalic, and the arch of the aorta, is surrounded by difficulties, which can be cleared up only by a careful stethoscopic examination of the part. In some aneurisms of the arch of the aorta, the sac rises up into the neck, so as closely to simulate a carotid aneurism, as in the annexed cut (Fig. 474); and this greatly increases the difficulty of the diagnosis. In such cases, Holmes suggests that the effect produced by carefully applied distal pressure may aid in the diagnosis. If, after a few hours, when the collateral circulation should be commencing to enlarge, the sac shows no signs of diminished tension, the case is very probably one of aortic aneurism. The principal affections of the neck, however, with which aneurism of the carotid may be confounded, are varix of the internal jugular vein, enlarged lymphatic glands, abscesses, tumours, cysts in the neck, and pulsating bronchocele.

A *dilated artery doubled upon itself* may closely resemble an aneurism when situated at the root of the neck. Such a case is recorded by Coulson. It occurred in an old woman of 88. No treatment was adopted, and after death the supposed aneurism was found to be a reduplication of the common carotid surrounded by indurated cellular tissue.

From *varix* the diagnosis may readily be made by attention to the following circumstances : that in varix the tumour is always soft, does not pulsate expansively, and diminishes in size during a deep inspiration, and on compressing the vein on its distal side.

Glandular tumours of the neck are often very difficult to distinguish from aneurism, more particularly when the artery passes through and is embraced by the tumour, so that the whole mass distinctly moves at each pulsation. In these cases also there may be an apparent diminution in the size of the tumour on compression, by the artery within it being emptied, or by the growth receding into some of the interspaces of the neck. But in the great majority of instances, attention to the globular, oval, and nodulated feel of glandular swellings, and the possibility of raising them up and pushing them away from the vessel—which may best be done by feeling the carotid with the ends of the fingers of one hand, and then pressing upon the tumour with the other—will reveal the true nature of the case.

From *abscess of the neck* the diagnosis must be made on general principles. The coexistence of ill-defined hardness and of enlargement of the glands, of an inflamed state of the skin, the ready detection of fluctuation, and the absence of expansile pulsation in the tumour, will show that it is not aneurismal, however its other characters may point to its being so. It is of importance to observe also that an aneurism that fluctuates is always forcibly distended with strong pulsation, and can be materially diminished by pressure, neither of which circumstances can possibly occur in abscess. But if abscess may be mistaken for aneurism, the converse also holds good ; and an aneurism may, unless care be taken, be mistaken for abscess—a far more fatal error. And there is one variety of false aneurism, that to which Liston has invited special attention, against which the Surgeon must be carefully on his guard, on account of the many points of resemblance between it and aneurism : I mean the case in which an artery has given way into the sac of an abscess. In this case, fluctuation and pulsation will exist, although not perhaps of a distending kind. An important diagnostic mark will be, however, that the outline of an aneurism is distinctly defined and limited, while that of an abscess never is. Aneurism of the internal carotid has been found by Syme to simulate very closely *abscess of the tonsil.*

Tumours of various kinds—carcinomatous, fatty, and fibrous—may occur in the neck, and cause some little embarrassment in the diagnosis from aneurism : thus Lisfranc, O'Reilly, and Kerr of Aberdeen have recorded instances in which the artery has been ligatured in such cases by mistake for aneurism. The diagnosis of such tumours as these must be effected on ordinary principles. I have in several instances met with a small, hard, distinctly circumscribed tumour lying directly upon the carotid artery, and apparently connected with it, and receiving pulsation from it, usually produced by a fit of coughing or laughing. This tumour, with the true nature of which I am unacquainted, remains stationary, and does not require any operative interference.

The thyroid body is not unfrequently the seat of enlargements, that have been mistaken for aneurism. These consist chiefly in a circumscribed enlargement of one lobe of the gland, which extends laterally over the common carotid, and receives pulsation from it. This kind of bronchocele may be diagnosed from aneurism by the communicated pulsation in it ceasing when it is raised from the artery. The most puzzling cases, and those in which mistakes may most easily be made, are instances of *pulsating bronchocele*, in which these tumours have an active and independent pulsation or thrill. In these instances, however, there are three points that will almost invariably enable the Surgeon to effect the diagnosis. Thus the tumour, although principally confined to one lateral lobe, always affects the isthmus more or less. Then again, in bronchocele, that portion of the tumour is most firmly fixed which stretches towards the mesial line; whilst in carotid aneurism the firmest attachment is under the sterno-mastoid muscle. The third point of difference is that, on desiring the patient to make an effort at deglutition, the enlarged thyroid body moves with the larynx and trachea. *Cysts in the thyroid body* are of more common occurrence than pulsating bronchoceles, and sometimes equally difficult of diagnosis. Dupuytren has pointed out that, when these cysts are tapped, the pulsation often becomes stronger, and the fluid, which on first flowing is serous, may at last become pure arterial blood, so that the Surgeon may suspect that he has punctured an aneurism.

TREATMENT.—**Digital Compression** has of late years been successfully employed for the treatment of carotid aneurism. A case of aneurism of the common carotid artery, cured by intermittent digital compression, has been recorded by Rouge of Lausanne. The patient was a man, aged 68. Compression was made by placing the thumb against the anterior edge of the sterno-mastoid and the next three fingers under the posterior edge of the muscle; the artery was thus seized and compressed. This avoided any pressure on the pneumogastric nerve, which was supposed to be the cause of the pain usually produced by attempts to compress the carotid. The compression was applied for seventeen days during seven or eight hours each day; and at the end of the time the man was cured. In addition to this, Holmes has collected four successful cases by Sheppard, Kerr, Humphry, and Gay, and two unsuccessful ones by De Castro and Delore. The pressure should, if possible, be applied above the transverse process of the sixth cervical vertebra, so as to avoid compressing the vertebral artery at the same time.

Ligature.—Since the time when Sir A. Cooper first ligatured the carotid, in 1805, the means on which the Surgeon almost always relies for the cure of aneurism of this vessel is deligation of the artery at a distance from the sac.

When the aneurism is so situated that a sufficient extent of healthy vessel exists between the sternum and the base of the tumour to admit of the application of a ligature, the Hunterian operation may be practised. If, however, the root or lower portion of the artery be so involved that there is no room to apply the ligature between the heart and the seat of the disease, the distal operation may be performed.

Ligature of the Carotid.—The patient must be placed upon his back with the shoulders supported by a pillow, and the head allowed to fall backwards so as to put the sterno-mastoid slightly on the stretch. In the later stages of the operation, the head must be brought a little more forward to allow the muscle to be drawn outwards. If brought too much forward the artery becomes relaxed, and the difficulty in passing the needle is increased. When the Surgeon can choose the spot at which to ligature the artery, he usually selects the part of the vessel which bisects the angle formed by the anterior edge of the sterno-mastoid with the omo-hyoid muscle at the level of the cricoid cartilage. The course of the artery is marked by a line drawn from the sterno-clavicular articulation to a point midway between the mastoid process and the angle of the jaw. The practical guiding line during the operation is the anterior border of the sterno-mastoid, which forms the first rallying point. The artery is reached by making an incision about three inches in length in this line, the middle of the wound being opposite the cricoid cartilage. After dividing the skin, superficial fascia, and platysma, with the branches of the superficial cervical nerve, and the deep cervical fascia, the fibres of the sterno-mastoid come into view; the inner border is easily found, and the muscle turned outwards. The second rallying point is the upper border of the anterior belly of the omo-hyoid. To bring this into view, the layer of cervical fascia forming the posterior part of the sheath of the sterno-mastoid must be dissected through, taking care not to wound the descendens noni nerve which usually lies immediately beneath it. When the muscle is found, its upper border is pushed downwards with the handle of the scalpel, and held out of the way with a blunt hook, and the sheath of the vessels then comes into view. The Surgeon now presses his finger backwards towards the bodies and transverse processes of the cervical vertebræ, and the artery will be felt rolling under the finger over the bone, and its exact position is thus easily ascertained. The vessel is enclosed in a sheath of cervical fascia

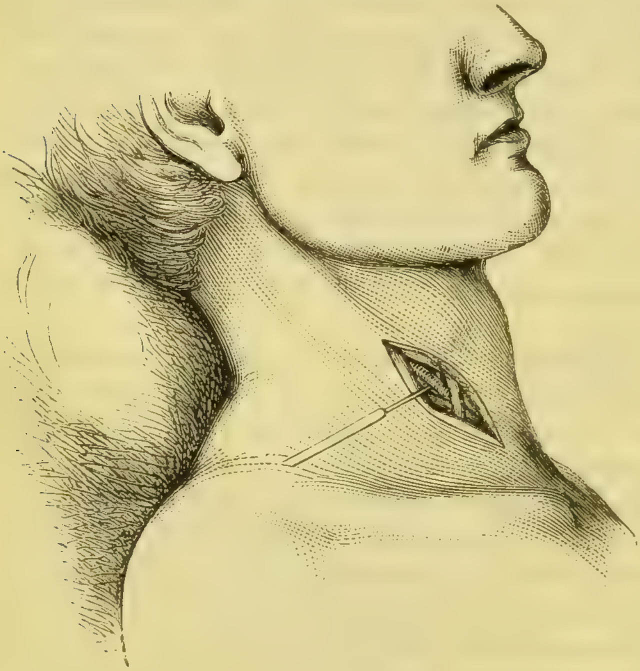

Fig. 475.—Incision for Ligature of the Carotid Artery.

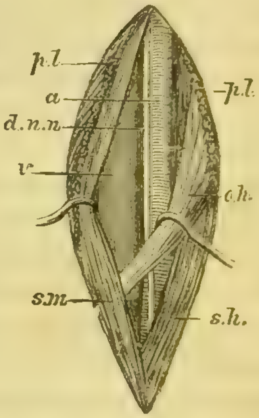

Fig. 476.—Diagram of the Right Common Carotid Artery at the seat of Ligature. *p.l.* platysma; *s.m.* sterno-mastoid, drawn to one side; *o.h.* omo-hyoid, drawn downwards and inwards: *s.h.* sterno-hyoid; *a.* the artery: *v.* internal jugular vein; *d.n.n.* descendens noni nerve. The pneumogastric is not seen, as it lies behind the vessels.

common to it, the internal jugular vein, and the pneumogastric nerve. This sheath is divided into three compartments by distinct fibrous septa, and it is important to open the most internal of these, in which the artery lies, if possible without disturbing the others. To do this, the common sheath must be opened well to the tracheal side, as the compartment for the vein is much larger than that for the artery, and occupies the greater part of the anterior aspect of the sheath which is exposed in the operation. After opening the common sheath, the special sheath of the areolar tissue surrounding the artery must be carefully divided until the white external coat comes into view. The needle is then passed from without inwards (Fig. 475), between the special sheath and the external coat, through the loose areolar tissue naturally found in this situation. If the vessel be properly cleaned, it is almost impossible to wound the vein or pick up the nerve. If, however, the wrong compartment of the common sheath be opened, or the special sheath not properly divided, either of these accidents may happen. Almost all the accidents which may happen in ligature of the carotid arise from one of two causes, either drifting too far outwards in the deeper parts of the incision, or not cleaning the vessel sufficiently before passing the needle. In cases of aneurism the difficulty is often increased by the proximity of the sac, and sometimes by inflammatory thickening of the sheath. In women the edge of the thyroid body may overlap the artery, and present a somewhat puzzling appearance when exposed. In performing the operation subcutaneous vessels are occasionally wounded, which may bleed rather freely ; if so, they should be ligatured. If the outer compartment of the sheath is accidentally opened, the jugular vein swells up so as to obscure the artery, but all difficulty from this source will cease if it be drawn aside by a retractor, or repressed by the assistant's finger. When this happens, it must not be forgotten that the septum of the common sheath, and the special sheath of the artery, have both to be divided before passing the needle. The pneumogastric nerve should never be seen, as it lies deeply behind the vessels.

After the operation the patient should be propped up in bed with the head forwards in order to prevent any strain upon the artery. Rest can be still more perfectly secured by applying a leather splint moulded before the operation to reach from the loins to the back of the head, and to overlap the shoulders. It can be put on immediately after the operation, and worn for the first two weeks.

Ligature of the Carotid below the Omo-hyoid becomes necessary if the aneurism have attained a very considerable size, extending low in the neck, and not leaving perhaps more than one inch of clear space above the clavicle. The operation is best performed by dividing the sternal head of the sterno-mastoid close to its origin. A V-shaped incision must be made, one limb of which corresponds to the lower two inches of the inner border of the sterno-mastoid, and the other to the inner two inches of the clavicle. The incisions are deepened till the muscle comes into view, the inner head is then divided and turned up in the V-shaped flap. The second rallying point is the edge of the sterno-hyoid. While searching for this, care must be taken not to wound the anterior jugular vein which crosses the muscle transversely on its way to join the external jugular. When the edge of the muscle is found, it may be drawn on one side with a spatula, or if necessary, notched. The sterno-thyroid scarcely requires division. The sheath of the vessels now comes into view, and must be cautiously opened, the Surgeon keeping carefully to the tracheal side so as to avoid the vein. There is usually a wide interval between the artery and the vein and nerve on the right side ; on the left side more care is required, as the vein most commonly overlaps the artery.

After ligature of the common carotid it is interesting to observe that the collateral supply is not afforded by any of the branches of the corresponding vessel of the opposite side, but by the subclavian artery of the same side. In a case related by Porter, in which the right carotid had been tied, the subclavian and vertebral arteries on the same side were enlarged to at least double their natural diameters, and the chief communications outside the skull took place between the superior and inferior thyroid arteries, which were enlarged ; whilst inside the cranium the vertebral took the place of the internal carotid. Immediately after the operation the blood may be so freely conveyed to the distal side of the vessel, by the free communication subsisting between the arteries of opposite sides, both within and without the cranium, that a continuance or a speedy return of pulsation in the sac is of common occurrence. This condition, however, usually disappears after a time by the gradual consolidation of the tumour, and indeed may generally be looked upon as a favourable sign ; being very seldom associated with those cerebral symptoms which, as will immediately be explained, commonly prove fatal after this operation. Occasionally the pulsation continues, and the tumour gradually increases in size in spite of the occlusion of the main trunk.

Suppuration of the sac is not of very uncommon occurrence after the ligature of the carotid for aneurism—sometimes even after so considerable an interval as eight months, as happened in a case related by Post. In the majority of these instances, the patient eventually does well ; but death may result by the tumour pressing upon the pharynx and larynx, or by the occurrence of secondary hæmorrhage, which may take place either from the part to which the ligature has been applied, or from the suppurating sac. In the first instance, it usually occurs about the period of the separation of the ligature ; in the second, it may happen at a considerably later period, even after many weeks. In a case under the care of H. Morris, suppuration took place round the sac fifteen weeks after the ligature was applied to the main trunk. Pus was let out by an incision, after which the tumour rapidly increased with return of pulsation. The sac was then laid open. The aneurism was found to have sprung from the external carotid, and the recurrent stream of blood was derived entirely from the branches of that vessel. The trunk above the sac, the facial, and the superior thyroid were ligatured, and the patient made a good recovery. As the suppuration is often due in all probability to the proximity of the wound and the ligature to the aneurism, it has been suggested that, in such cases, it might be safer to anticipate it by laying open the sac after the application of the ligature on the proximal side, and tying the vessel again on the distal side, thus performing a combination of Anel's and the old operation. It would appear, however, as if this were only substituting a certain evil for one that may very possibly be avoided. Besides these, which may be looked upon as the ordinary accidents following the application of a ligature for aneurism, deligation of the carotid artery occasionally gives rise to serious and even fatal disturbance of the circulation within the cranium.

Effects on the Brain of Ligature of one or both Carotids.—Many experiments have been made by Meyer, Jobert, and others, upon the lower animals, with the view of determining the effect produced on the brain by the ligature of the carotid arteries. But the deductions from these are of no value whatever when applied to the human subject, for the simple reason (which appears to have been strangely overlooked), that in many of the lower animals on which the observations were made, as the dog and rabbit, for instance, the common carotid arteries are of secondary importance so far as the cerebral circulation is concerned, being destined principally for the supply of the external parts of the head—the brain deriving its chief supply from the vertebrals: whilst in other animals, as the horse, the brain derives nearly the whole of its blood from the carotids, and but a very small quantity from the vertebrals. Hence, in one case the carotids may be ligatured without danger, whilst in the other their deligation is inevitably fatal. The statistics of ligature of the carotid in the human subject have been collected by Norris, Ehrmann, and others; and more recently by Pilz of Breslau (*Archiv für Klinische Chirurgie*, 1868), who has collected 600 cases of the operation, including 27 in which the artery was tied on both sides. The causes which led to the operation were, hæmorrhage, in 228 cases: aneurism, in 87; erectile and other tumours, 142: extirpation of tumours, 71; cerebral affections (epilepsy, &c.), 34; and in 38 instances the distal operation was performed for aneurisms of the aorta and innominate artery. In the 228 cases of ligature for hæmorrhage, the presence of cerebral symptoms is noted in 69 out of 167—no information being given in regard to 61; and, in these 69 cases, death took place in 40. Excluding, however, these from calculation, inasmuch as the brain-disorder may have been in many due to the hæmorrhage rather than to the operation, we derive from Pilz's statistics the following table showing the proportionate frequency of the occurrence of cerebral disease and of deaths from this cause.

TABLE OF LIGATURE OF CAROTID FOLLOWED BY CEREBRAL DISEASE.

CAUSES OF OPERATION.	NUMBER OF CASES.	CASES IN WHICH CEREBRAL AFFECTION ENSUED.	DEATHS FROM CEREBRAL DISEASE.	DEATHS FROM ALL CAUSES.	NO RECORD REGARDING CEREBRAL SYMPTOMS.
Aneurism	87	32	16	31	5
Erectile and other Tumours .	142	32	20	49	3
Extirpation of Tumours .	71	13	8	25	8
Cerebral Affections . . .	34	8	...	1	3
Distal Operation	38	11	7	25	0
	372	96	51	131	19

By this it will be seen that the most common cause of death after ligature of the carotid is cerebral disease induced by the operation (as was, I believe, first pointed out by Chevers): and this result appears to have been relatively more frequent after the distal than after the Hunterian operation. If to these cases we add 14 in which the brachio-cephalic artery was ligatured, we get a total of 386 cases, of which 96 were attended by cerebral symptoms; or, as nearly as possible, 25 per cent.

We should naturally expect that, in those cases in which both vessels had been ligatured, there would be a greater tendency to cerebral disturbance than in those in which only one had been deligated. It would however appear, as is shown by the following table, that of twenty-seven instances in which the double operation has been performed, death is recorded to have happened but in two cases from this cause; while in another, in which convulsions took place, a fatal result did not occur, and three other cases were attended by mere temporary disturbance of vision. In the only case (that of Mott, No. 16) in which both carotids were ligatured simultaneously, with an interval of only a few minutes between the operations, coma and death resulted.

CASES OF LIGATURE OF BOTH CAROTIDS.

OPERATOR.	AGE.	DISEASE.	DATES OF LIGATURE.	RESULTS.
1. DUPUYTREN and ROBERT.	...	Aneurism by anastomosis of scalp.	Right carotid tied by Dupuytren in 1819; left by Robert for extension of disease, in 1857.	Delirium, hemiplegia of left side, and death.
2. MACGILL.	...	Fungous tumour of both orbits.	Interval of a month.	Recovered.
3. ULLMAN.	20	Erectile tumour of orbit.	Left tied first, 1823; right one year afterwards.	Death on third day by hæmorrhage.
4. MUSSEY.	20	Aneurism by anastomosis of scalp.	Left carotid, Sep. 20; right carotid, Oct. 2, 1827.	Recovered.
5. MÖLLER.	4½	Erectile tumour.	Sept. 13, 1831, and Jan. 28, 1832.	Recovered.
6. PRESTON.	50	Epilepsy; Hemiplegia.	Right carotid, tied Aug. 23; left carotid, Nov. 14, 1831.	Recovered.
7. PRESTON.	24	Partial paralysis and headache.	Right carotid, Sept. 7; left Oct. 10, 1831.	Recovered.
8. PRESTON.	...	Epilepsy.	Tied at interval of month.	Recovered.
9. KUHL.	53	Aneurism by anastomosis of scalp.	Left carotid, May 24, 1834; right on Aug. 4, same year.	Recovered: convulsions after each operation.
10. F. H. HAMILTON.	18	Epilepsy.	Right carotid, Aug., 1838: left, March, 1839.	Recovered.
11. VELPEAU.	29	Aneurism by anastomosis of both orbits.	Right carotid first, August, 1839: left, about three months afterwards.	Recovered.
12. PIROGOFF.	20	Hæmorrhage from aneurism by anastomosis of scalp.	Left carotid, Jan. 16, 1843: right, Jan. 9, 1844.	Headache and vomiting after each operation: recovery.
13. ELLIS.	21	Secondary hæmorrhage following gunshot wound of tongue.	Interval of four-and-a-half days.	Cured.
14. J. M. WARREN.	23	Erectile tumour of face.	Left, October 5; right, Nov. 7, 1845.	Cured.
15. ROBERT.	...	Aneurism by anastomosis of forehead.	Left on June 5, 1846; right on Feb. 22, 1847.	Headache: temporary disturbance of vision: recovery.
16. MOTT.	...	Carcinoma of parotid.	Interval of fifteen minutes.	Coma, and death in 24 hours.
17. MOTT.	...	Epilepsy.	Interval of half a year.	Recovered.
18. BLACKMAN.	15	"Fungus of nasal fossæ."	Right first; left, three weeks later.	Temporary loss of vision of left eye: recovery.
19. MUSSEY.	19	Erectile tumours.	Left first; right, one month after.	Temporary derangement of vision: recovery.

CASES OF LIGATURE OF BOTH CAROTIDS—*continued.*

OPERATOR.	AGE.	DISEASE.	DATES OF LIGATURE.	RESULTS.
20. REYNOLDS and VAN BUREN.	...	Aneurism by anastomosis.	Right carotid tied by Reynolds in 1844; left by Van Buren in 1850.	Recovery.
21. PARKER.	45	Carcinoma of antrum.	Interval of thirty-two days.	Death.
22. WOOD.	53	Encephaloid of antrum.	Right carotid, July 18; left, Dec. 26, 1856.	After second operation the tumour diminished: then diarrhœa, rigors, delirium, exhaustion, and death on sixtieth day.
23. G. C. E. WEBER.	30	Epilepsy.	Left carotid. Dec. 2; right, Dec. 19, 1857.	Recovered.
24. CARNOCHAN	...	Large morbid growth of face (elephantiasis).	Right carotid tied, Nov., 1858; left, June, 1859.	Cured.
25. LONGMORE.	...	Gunshot wound.	Right, May 12, 1863; left, May 18.	Death in thirty-eight hours.
26. BILLROTH.	27	Ulceration of carotid from syphilitic caries of petrous bone; Hæmorrhage.	Right carotid, Dec. 13; left, Dec. 26, 1864.	Return of hæmorrhage on sixteenth day: death from exhaustion: no cerebral symptoms.
27. BUENGER.	34	Aneurism by anastomosis and wound.	Left tied for the aneurism; five years afterwards the right, for a suicidal wound.	Disorganization of right eye: recovery.

After a careful examination of this subject, I think we are warranted in coming to the following conclusions: 1. Ligature of one carotid artery is followed by cerebral disturbance in more than one-fourth of the cases, above one-half of which are fatal. 2. When the two carotids are ligatured *with an interval of some days or weeks*, the operation is not more frequently followed by cerebral disturbance than when only one is tied. 3. Pathological investigation has shown that, if the vessels be gradually and successively obliterated, the patient may live, although one carotid and one of the vertebral arteries have been occluded by disease and the other carotid ligatured, as in a case related by Rossi. 4. As in a case recorded by Davy, an individual may even live for a considerable time, though both carotids and both vertebrals be occluded—the cerebral circulation being maintained through the medium of the anastomoses of the inferior and superior thyroids and the deep cervical with the occipital artery. 5. The reason why more or less extensive obstruction by disease of the arteries leading to the brain may, as appears from pathological records, be unattended by cerebral disturbance, while this so frequently follows ligature, is (as has been pointed out by Pilz) that in the former case the obstruction is gradual, so that the collateral circulation has time to be established, while in the latter the interruption is sudden.

The cause of these *cerebral symptoms* is certainly the disturbance of the cerebral circulation, induced by the ligature of the carotid. When a considerable portion of the supply of blood to the brain is suddenly cut off, two sets of symptoms may ensue—one *immediate*, the other *remote.* The immediate symptoms are those that generally result from functional disturbance of the brain, consequent upon too small a supply of arterial blood. They consist of syncope, trembling, twitches, giddiness, and impairment of sight. After this condition has been maintained for a few days, the nutrition of the organ becomes materially affected, and softening of the cerebral substance takes place; giving rise to a new and more serious set of symptoms indicative of this pathological condition, such as convulsions, hemiplegia, and death. In other cases congestion may come on, either by the interference with the return of blood through the jugular vein, or as a consequence of that venous turgidity which we commonly observe after the ligature of a main arterial trunk; or perhaps coma may be induced by apoplectic effusion into a softened portion of the organ.

Effects on the Lungs.—Besides the brain, the lungs are not uncommonly secondarily affected after ligature of the carotid. To this condition special attention was directed by Jobert and Miller. The lungs appear to become greatly congested, and this condition has a tendency to run into a subacute form of inflammation. The cause of this congestion of the lungs is extremely interesting. It cannot be owing to any injury sustained by the eighth nerve during the deligation of the artery; as in many of the instances in which it is stated to have occurred, there was no evidence of that nerve having been exposed or damaged, and every reason, from the known skill of the operators, to believe the contrary. I am rather inclined to look upon the unusually frequent occurrence of pulmonic congestion after ligature of the carotid, as a secondary condition consequent upon a derangement in the functions of the brain and medulla oblongata, primarily induced by the disturbed state of the circulation through that organ; for we know that any cause which depresses the activity of the nervous centres tends to diminish proportionately the freedom of the respiratory movements, and thus, by interfering with the due performance of the act of respiration, disposes to congestion of the lungs, as seen in injuries of the head, in apoplexy, and in the operation of the sedative poisons. It would appear from some of the recorded cases, as well as from Jobert's experiment, that blood-letting is of considerable service in the removal of this condition, and it should consequently not be omitted.

Ligature of the Carotid on the Distal Side of the Sac.—Aneurism of the carotid artery, occurring low in the neck, does not admit of the application of a ligature on the cardiac side of the tumour. What, then, is to be done in such a case as this? Should it be left to the remote chance of a spontaneous cure, or should it be subjected to surgical interference? Spontaneous cure in carotid aneurism has never yet, I believe, been met with. The Surgeon, therefore, must endeavour to treat the disease by ligature. Two plans of treatment are open to him—either to tie the innominate artery if the tumour be on the right side, or the carotid on the distal side of the tumour. The first alternative may fairly be set aside; for not only are the cases in which it is possible to find room between the sternum and the sac extremely rare, but, even were such an instance to present itself, Surgeons would, I think, scarcely ever be justified in undertaking an operation which has only once succeeded (p. 196); we are consequently reduced to the alternative of ligaturing the artery on the distal side of the sac. But although this operation is the only alternative that presents itself, yet its application in practice is attended by serious difficulties and perplexities; for the Surgeon must be able to satisfy himself that it is actually an aneurism of the root of the carotid with which he has to do, and that it is not the trunk of the innominate or the arch of the aorta that is affected. The difficulty in doing this is far greater than would at first appear; for, on examining the details of eight cases in which the distal operation has been performed for supposed carotid aneurism, three must be excluded; as, after death, the tumour was found to arise from the aortic arch. In the annexed table will be found the results of eight cases, in which the carotid artery has been tied for aneurism of its root on the distal side of the sac. I have excluded a ninth case, as there is reason to believe that in it the artery was not ligatured, but a portion of the sheath accidentally tied instead—an accident, by the way, which Sédillot has witnessed, which Norris states also to have occurred at the New York Hospital, and which I have known happen to a most excellent Surgeon in the case of ligature of the femoral artery.

ANEURISM OF ROOT OF CAROTID TREATED BY LIGATURE ON DISTAL SIDE.

OPERATOR.	SEX.	AGE.	RESULT.	CAUSE OF DEATH.	REMARKS.
1. Wardrop. 1826.	f.	63	Recovered.	... ...	Tumour diminished until fifth day; then inflamed, suppurated, and burst. The patient recovered, and was alive three years after operation.
2. Lambert. 1827.	f.	49	Successful so far as aneurism was concerned.	Hæmorrhage from upper portion of artery.	Tumour diminished after operation. and became consolidated; sac filled with firm coagulum, and lower part of artery closed; ulceration into artery, just above part ligatured; vessel dilated where ligatured.
3. Bush. 1827.	f.	36	Recovered.	... ...	Suffocation was imminent before operation; tumour rapidly diminished after ligature. Alive three weeks afterwards.
4. Montgomery. 1828.	m.	30	Died.	Sac suppurated.	Aneurism of arch also. Left carotid tied.
5. Colton de Noyou. 1840.	f.	63	Recovered.	... ...	Tumour and pulsation diminished. Alive and well three years afterwards.
6. Wood, J. R. 1840.			Recovered.	... ...	Aneurism cured.
7. Demme.	m.	38	Died.	Suppuration of sac: hæmorrhage.	Aneurism of arch: double aneurism of carotid.
8. Lane. 1852.	m.	36	Died. 68th day.	Inflammation of lungs.	Tumour filled with layers of coagulum. Ulcerated opening communicating with apex of left lung. Left carotid tied.

On analysing the cases in which the trunk of the common carotid has been ligatured on the distal side of an aneurism of the root of that vessel, there are several points of interest that arrest our attention. Thus we find that in every case the tumour, immediately on the ligature being tightened, underwent a considerable diminution in its bulk, with corrugation of the integuments covering it, and considerable subsidence in the force of its pulsations. In one case—that of Bush—respiration, which before the operation had been greatly embarrassed, became easy; and in two others inflammation of the sac took place, being in one (that of Wardrop) unattended by bad consequences, and in the other (Demme's case) followed by death. It is not safe to deduce any general conclusion from so small a number of cases; yet the result of these is so uniform, that I have no hesitation in stating it as my opinion that, whether we regard the principle on which this operation is founded, the amount of success which has hitherto attended it, the necessarily fatal result of these cases if left to themselves, or the absence of any other means that hold out a reasonable hope of benefit, the Surgeon is justified in resorting to the ligature of the trunk of the common carotid on the distal side of the sac, in cases of aneurism limited to the root of that vessel.

The trunk of the **External Carotid** is so short that it seldom becomes the seat of aneurism without involving at the same time the common artery at its bifurcation. It may, however, become aneurismal. The tumour, presenting the usual signs of aneurism, will be found situated under the angle of the jaw and above the level of the cricoid cartilage. From the important nature and close proximity of the parts surrounding it, the pressure-effects are serious and early. By pressure on the hypoglossal nerve the muscles of the corresponding side of the tongue may be paralysed, so that when protruded the tongue is turned towards the affected side. Aphonia and dysphagia have been met with as early symptoms.

The treatment consists in ligature of the common carotid above the omohyoid. After this operation it may happen that pulsation continues faintly, or speedily returns to the sac, owing to the freedom of enlarged anastomoses. It has, therefore, been proposed by Morris to ligature the primary branches of the external carotid as well—a project certainly difficult in execution and probably of doubtful utility.

ANEURISM OF THE INTERNAL CAROTID.

The Internal Carotid Artery may be the seat of aneurism before or after it has entered the cavity of the skull. The symptoms of these two classes of cases differ necessarily in almost every respect.

Extracranial Aneurism.—When an aneurism affects the trunk of the internal carotid before its entrance into the skull, the symptoms do not materially differ from those of aneurism at the bifurcation, or of the upper part of the common carotid, except in one important respect, which was, I believe, first pointed out by Porter of Dublin—viz., the tendency of the tumour to extend inwards towards the pharynx, and to protrude into that cavity. The reason of this is obvious: when we consider the anatomical relations of the internal carotid artery, we at once see that its pharyngeal aspect is that which, if one may so term it, is the most superficial—nothing lying between the vessel and the mucous membrane except the thin paper-like constrictor, some lax areolar tissue, and the superior laryngeal nerve: whilst externally there are interposed between it and the integument the layers of the cervical fascia, the margin of the sterno-mastoid, the digastric, stylo-hyoid and stylo-pharyngeus, and the styloid process, and above the digastric the parotid gland.

When, therefore, dilatation of the vessel takes place, it necessarily has a tendency to push forwards that part of its covering where it meets with least resistance; and, this being to the pharyngeal side, more or less prominence will be found in this cavity. In a case that occurred to Syme, this was especially well marked, the aneurism of the internal carotid simulating closely an abscess of the tonsil. In two cases related by Porter in the seventeenth volume of the *Dublin Journal of the Medical Sciences*, this was one of the most marked features: the "appearances of the tumour (as seen by the mouth) were most alarming; the pulsation could be distinctly seen, and the blood almost felt under the mucous membrane; it seemed ready to give way and burst into the mouth every moment."

Treatment.—The treatment of these cases does not differ from that of aneurisms connected with the carotid arteries, and seated at the upper part of the neck; but we are not in possession of a sufficient number of facts to enable us to determine with any degree of precision what the result of surgical interference in them is likely to be. If we could give an opinion from the limited number of cases at present before the profession, we should feel disposed not to entertain a very favourable opinion of the result of the Hunterian operation, as applied to aneurism of the internal carotid outside the skull. This is doubtless owing to the situation of the aneurism against the mucous membrane of the mouth, being such that the surrounding tissues do not exercise a sufficient amount of pressure against the sac after the ligature of the vessel to allow the efficient deposition of lamellated coagulum, and consequent occlusion of the artery leading into it, which, in accordance with the principles that have been laid down in speaking of the Hunterian operation, are necessary to success.

INTRACRANIAL ANEURISM.

Aneurisms within the skull may arise from any of the arteries that are met with in this situation, though some are much more liable than others to the occurrence of this disease. Of 62 cases noted by Sir W. Gull, the basilar artery was the seat of disease in 20 cases, and the middle cerebral in 15. In 8 of the remaining cases, the internal carotid was affected as it lay by the sella Turcica; and in 6 others the anterior cerebral artery was the seat of aneurism. The vertebral arteries and their branches were affected in 28 cases, and the carotids and their branches in 34.

Causes.—The causes of intracranial aneurism are very obscure. It might be supposed that the comparatively small diameter of the arteries within the skull would render them little liable to the occurrence of spontaneous aneurism, were it not that the anatomical characters and physiological relations of these vessels predispose considerably to the occurrence of this affection; there being no other set of arteries in the body of the same size as these within the skull in which spontaneous aneurism so frequently occurs. This can be accounted for only by the thinness of their coats and want of an external fibrous sheath rendering them unable to support the increased tension, to which they are occasionally subjected in consequence of the alteration in pressure of the cerebral circulation at different periods, the result of some variation in the relative quantities of the different fluids within the skull, or of determination of blood to the brain. This would be the case more particularly if their natural elasticity had already been impaired by the occurrence of degeneration of their coats. As these changes are the natural consequences of advance in age, we shall find the tendency to the occurrence of this disease increases with advancing years. Thus, according to Sir William Gull, of 58 cases in which the patient's age is given, only 12 cases appeared in persons under twenty-five, five of the patients being under twenty; of the remaining 46 cases, 13 occurred in persons under forty; of the remaining 33, 22 were met with between forty and sixty and 4 in persons above sixty. Of the 58 cases, 35 were males, and 23 females. Church believes that, in the young, intracranial aneurism is due to embolism.

The immediate exciting cause of the disease is most commonly involved in obscurity: sometimes it may be traced to a blow on the head, to a fall or concussion, or to excess in drinking; but more frequently the symptoms manifest themselves suddenly, without being in any way attributable to such external influences, and occur in vigorous and apparently healthy persons.

Pathology.—Intracranial aneurisms are almost always formed by the uniform dilatation of the whole of the calibre of a limited portion of the artery—the sacculated variety being rarely met with. In the museum of University College there are, however, two specimens of sacculated aneurisms of the cerebral arteries. The coats of the arteries in this situation being very thin, and unprovided with any external fibrous sheath, rupture of the vessel is more common than partial dilatation, when one portion only of the circumference is diseased. Occasionally, the dilatation is fusiform, extending over some length of the artery: this form is probably confined to the basilar artery (Fig. 477).

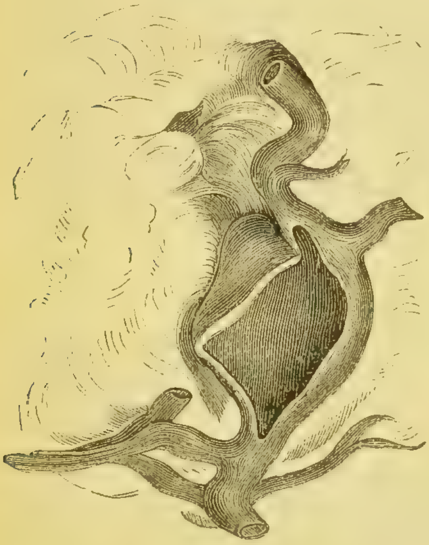

Fig. 477.—Fusiform Aneurism of Basilar Artery laid open.

The disease would appear to be of slow growth, and the sac sometimes becomes filled with laminated coagula so completely as to occlude the artery from which it springs.

The size that aneurism in this situation attains before death results is sometimes considerable: thus, in a case of aneurism of the basilar artery, that occurred some years ago at the University College Hospital, the tumour was nearly as large as a walnut; in another case, in the same Hospital, it somewhat exceeded this size. R. W. Smith, in the *Dublin Journal of the Medical Sciences*, vol. xxv., mentions a case of multilocular aneurism of the left posterior cerebral artery as large as a small apple; and Serres, one as large as a hen's egg. On the other hand, they occasionally prove fatal by rupture while still of very small size—not larger than a pea or a nut.

It is seldom that more than one of the arteries of the brain suffer aneurismal dilatation. In the Museum of the College of Surgeons, however, are the preparations (Nos. 1687 and 1688) of aneurismal dilatation of both internal carotid arteries.

A case occurred in University College Hospital under the care of A. T. Thomson, in which a somewhat similar condition existed. A man, forty-nine years of age, had fallen on his head some months before admission into the Hospital. Since then he had been garrulous, silly, and very irritable—becoming readily intoxicated. He suddenly became comatose, with vomiting and laborious breathing ; he could close both eyes, but the right pupil was dilated ; the left side was paralysed. He was treated for apoplexy, and became slightly better, but died in ten days from the first attack. On examination, an aneurism a little larger than a hazel-nut was found on the trunk of the right carotid, where it gave off the middle cerebral, and another small one on the course of that artery. There was a globular aneurism on the corresponding artery of the opposite side ; the basilar artery was thickened, white, and opaque, as were also the other larger arteries of the brain; there was softening of both anterior cerebral lobes, especially the right.

The arteries of the brain are very commonly healthy in these cases. Out of four cases of intracranial aneurism, that have fallen under my observation, the other vessels of the brain have been healthy in three cases, and atheromatous in but one. In one case I have seen aneurism of the skull associated with aneurism elsewhere—in the thoracic aorta.

Pressure-Effects.—The pressure exercised by an aneurismal sac situated within the skull is always chiefly directed against the yielding cerebral substance, which is often extensively disorganized. The bones of the skull, however close their proximity to the sac may be, frequently escape, and seldom suffer much. This peculiarity in the effects of aneurism in this situation may be partly owing to the very dense and compact character of the inner layer of the skull, but is doubtless principally due to the very soft and yielding nature of the contents of the cavity. Absorption of the subjacent bone, however, sometimes take place to a limited extent ; thus in one case (Moore's) the body of the sphenoïd bone was indented and partially absorbed.

The parts compressed in each case will vary according to the situation of the tumour. But the structures that principally suffer are necessarily those seated at the base of the brain, and forming the floor of the lateral ventricles. In Moore's case, one of the optic nerves was flattened ; the lamina perforata, the roots of the olfactory tract, the anterior part of the corpus striatum, and a considerable quantity of the neighbouring white matter of the anterior lobe, were destroyed. In a case recorded by Lager, the portio dura of the right side was paralysed from this cause. In R. W. Smith's case, the floor of the third ventricle, the tuber cinereum, and the origins of the optic and olfactory nerves, suffered ; the optic nerve of the opposite side was flattened and softened.

Besides the changes that take place in the cerebral substance as the result of pressure, important lesions may be met with as the effect of the interruption which the presence of the aneurism offers to the circulation in and nutrition of the cerebral hemispheres. Thus, in the case of aneurism of both internal carotids that has already been referred to as occurring at University College Hospital, there was white softening of both the anterior cerebral lobes ; and this lesion was most marked on the side that corresponded to the larger aneurism, and where consequently, it may be supposed, the greater amount of obstruction to the circulation existed.

Symptoms.—The symptoms of aneurism within the skull are extremely equivocal ; and, indeed, aneurism of large size may exist at the base of the brain without occasioning any symptoms whatever. An interesting instance of this occurred at University College Hospital in 1848. A man, thirty-seven years of age, died of pulmonary apoplexy and chronic pneumonia of the left lung, consequent upon the pressure of an aneurism of the commencement of the descending aorta on the pulmonary veins of that side. On examining the head after death, an aneurism of the basilar artery as large as a hazel-nut was met with, of which no suspicion had been entertained during life, there having been no head-symptoms whatever; the sac was very thin, and there was much atheromatous degeneration in the vertebral arteries.

The only symptoms that are of constant occurrence, when this disease goes on to a fatal termination, are those of hemiplegia and apoplexy. These may come on suddenly without any previous warning; or they may be preceded by a train of phenomena indicative of the existence of chronic disease within the cranial cavity. The most constant of these phenomena is pain; which shows, however, great variety, both in extent and in character. It may be diffused, or may occupy a fixed point; it may be continuous or intermitting; it may be increased by movement, or accompanied by peculiar sensations, as of pulsation or of opening and shutting the top of the head.

The sight and hearing are often impaired. Dimness of sight, dilatation of one or both pupils, photophobia, diplopia, and loss of vision have been noticed in several of the cases recorded. Gowers states that intracranial aneurisms even of large size, are not as a rule accompanied by any associated ocular changes. Nor do they often cause consecutive changes, unless their position is such as to press upon the optic nerves: there is then loss of vision with atrophy of the nerve recognizable by the ophthalmoscope. If the aneurism press on the cavernous sinus, there may be some fulness of the retinal veins, but this is usually only temporary, the pressure being relieved by the free communication between the ophthalmic and facial veins. Optic neuritis is rare as the result of intracranial aneurisms. Ptosis has been met with from pressure on the third nerve by aneurism of the posterior communicating artery. Buzzing noises in the ears, and deafness, are not uncommon symptoms; deafness, more particularly, appears to be a phenomenon of frequent occurrence. The patient rarely loses the power of articulation and of deglutition; impairment of these functions, however, has been met with. There may be paralysis of the side of the face, shaking palsy, or complete hemiplegia; or fits and epileptiform convulsions may occur. The mental condition may undergo changes indicative of chronic disease of the brain. There may be depression of spirits, listlessness, or, as was noticed in the case above related, the temper may become irritable, and the patient be garrulous or silly. Insanity has been noticed in one case. As is commonly the case in cerebral affections, the gastric functions are often impaired.

In some cases the presence of aneurism has been detected by a loud rough or "whizzing" noise heard on the application of a stethoscope over one side of the head, and, perhaps, audible to the patient. This sign, however, exists in but few cases; but when it does occur, it is unquestionably the most pathognomonic of all. I am not aware that it has been met with in any form of cerebral disease except intracranial aneurism.

Thus it will be seen by a reference to this list of symptoms that, with the exception of the whizzing noise, no special signs are afforded by aneurisms within the skull, which will enable us to distinguish between the symptoms occasioned by their presence and those of other tumours of the brain, and of organic cerebral disease. Very frequently no premonitory symptoms manifest themselves; the patient being suddenly seized when apparently in good health, with apoplexy, which terminates rapidly in death.

Causes of Death.—The fatal termination may occur from one of four causes.

1. The tumour may exercise such *pressure upon the whole cerebral mass* as to occasion death. This mode of termination is rare. I am acquainted with one case of this description, which is reported by Ruschenberger. The symptoms were very remarkable, consisting of complete hemiplegia of the left side, with involuntary antero-posterior vibration of the head and body, and paralysis agitans of the right leg. The patient slept heavily, with loud snoring; he ate voraciously, but occasionally had considerable difficulty in deglutition and articulation; his intellect was clear, but very slow. After death, an aneurism of the basilar artery as large as a pigeon's egg, containing an irregular, very hard, dry clot of blood, was found pressing on the pons Varolii. The sac had given way at one point, extravasation taking place into the substance of the pons, which was softened, and of a bluish colour.

2. The most frequent mode in which death takes place in these cases is by the *sudden rupture of the sac* and extravasation of blood into the cavity of the arachnoid and the meshes of the pia mater at the base of the brain, or into the lateral ventricles—either from the aneurism projecting into them and there giving way, or rupturing into these cavities by breaking down the intervening cerebral substance (Figs. 478, 479). When this mode of termination occurs, there are occasionally no premonitory symptoms of impending danger; the patient, when apparently in good health, being struck down by an attack of apoplexy which is speedily fatal. More frequently a series of those symptoms that have already been mentioned as attending many cases of this disease, precede the fatal event for a longer or shorter time. When rupture of the sac and extravasation of blood take place, death is inevitable; at least, I am not acquainted with any case in which the appearance found after death converted me to the belief that the patient had even temporarily recovered from this condition.

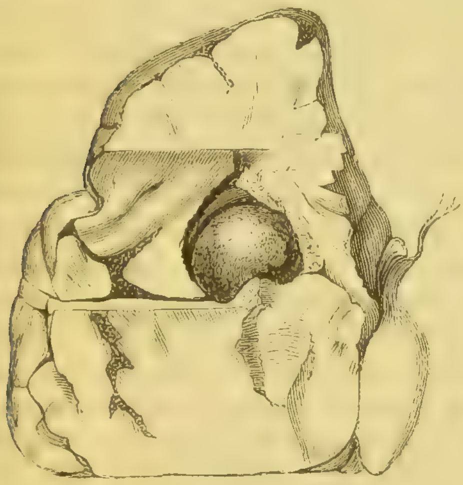

Fig. 478.—Aneurism of the Left Internal Carotid, bursting into Lateral Ventricle. View of Aneurism from above, projecting into Ventricle.

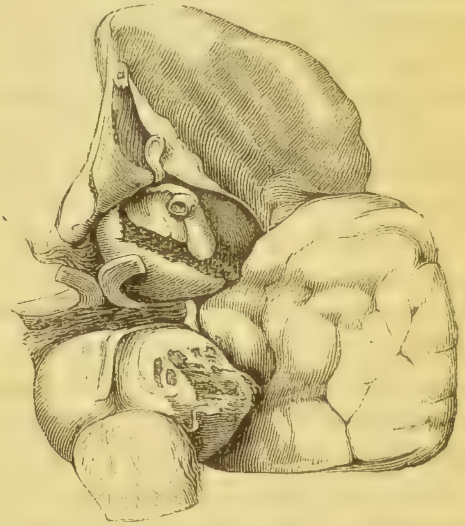

Fig. 479.—View of the same Aneurism from below, imbedded in substance of Hemisphere.

Death from rupture of the sac appears to be most frequent in younger subjects. In the later period of life, aneurism is commonly associated with atheromatous disease of the vessels generally, which may cause death by softening and effusion of blood. According to Gull, of 20 cases occurring in persons under thirty-five years of age, 16 (or 80 per cent.) were fatal from rupture of the sac ; while in 37 cases over thirty-five, death occurred from this cause in only 14, or 38 per cent.

3. Death may result from another cause than the pressure of the aneurismal sac or its rupture and the extravasation of its contents—viz., from *softening of the substance of the brain* to a greater or less extent, in consequence of the obstruction offered to the passage of the blood through the aneurismal vessel. In the case of aneurism of both carotids, already mentioned as having occurred at University College Hospital, this was the case ; both anterior cerebral lobes were affected with white softening, and this condition was especially observable on that side on which the aneurism was larger.

4. Lastly, death may be produced by the mere *irritation* occasioned by the pressure of one or more aneurismal tumours within the cranium. Of this an interesting example is afforded by the history of the case of aneurism of both internal carotids, referred to on p. 184, related by Sir G. Blane in the *Transactions of the Society for the Improvement of Medical and Chirurgical Knowledge*, vol. ii. p. 192. In this case the patient, a lady aged 69, had suffered for four years from attacks of giddiness, headache, and imperfect vision ; about sixteen months before her death she became insane, recovered, and then relapsed twice into the same state. After having regained her senses for some months, she became affected with giddiness, redness of the eyes, and violent maniacal delirium, which continuing for some weeks caused her death.

After death the following appearances were found. "Upon examining the body, there was no appearance in the brain itself that could in any way account for the symptoms. There was, indeed, a greater quantity of fluid than common in the ventricles, and the surface of it was moister than it is usually found in a sound state ; but in all other cases which have occurred to me of organic affections of the brain proving fatal, except those which are sudden, such as apoplexy, there has been a preternatural quantity of fluid in its ventricles. There were also spicula of bone in the membrane forming the falx. The inner substance of the crura cerebri was of a brown colour, and more tender than natural. The optic nerves were smaller than natural, as if they had been wasted. The septum lucidum was more than usually dense.

"But the morbid appearance in this case, which was so singular, and to which the symptoms of complaint seemed chiefly referable, was two bulbs, about five-eighths of an inch in diameter, filling up the hollow on each side of the sella Turcica, which were evidently dilatations of the carotid arteries, and, from their being filled with laminæ of coagulated blood, there could be no doubt of their being aneurisms of these arteries. The dissection was made by Mr. Hunter, assisted by Mr. Home, in the presence of Dr. Jenner and myself, and all concurred in the opinion that these tumours were aneurisms. The one on the left side was the largest. That on the right side communicated with the cavity of the artery, which was not the case with the other."

Treatment.—In the treatment of intracranial aneurism there is usually little to be done, the nature of the case not being sufficiently obvious in the majority of instances to justify active measures. Should, however, the loud rough whizz be distinctly audible over one side of the head, more especially about the base of the skull, or by application of the stethoscope to the mastoid process, and should symptoms of cerebral compression begin to manifest themselves, ligature of the carotid artery on the affected side may with propriety be practised. This has been done successfully in a most interesting and instructive case of intracranial aneurism by Coe of Bristol ; and unsuccessfully in one at University College Hospital, by Berkeley Hill, in which death took place from hæmorrhage from the seat of ligature.

INTRAORBITAL ANEURISM.

"Intraorbital aneurisms" were for a long time considered by Surgeons to be of the nature of erectile tumours ; but the error of this opinion was pointed out by Busk, and subsequently by Nunneley, who conclusively showed that except in those very rare cases in which a pulsating tumour of the orbit is congenital, or has appeared shortly after birth, or is associated with nævoid tissue developed in the eyelids, it must be looked upon as being due in the vast majority of cases to the presence of an aneurism or aneurismal varix at the back of the orbit. These views have been fully confirmed by Rivington in his exhaustive paper founded on 73 recorded cases of pulsating tumour of the orbit collected from various sources, and including one very interesting case of his own. The vessel affected seems to be in some instances the ophthalmic artery itself ; in other instances it would appear that the tumour is developed within the cranium, springing from the carotid artery, the ophthalmic being but secondarily affected. Delens of Paris has recorded three cases verified by *post-mortem* examination, in which the symptoms arose from an arterio-venous aneurism affecting the carotid artery in the cavernous sinus.

Causes.—The causes of intraorbital aneurism are in some cases very obscure ; in others, it evidently has originated from a blow upon the head. In the first class of cases, where the disease has been of spontaneous origin, the patient has suddenly felt a crack or snap in the orbit, like the "crack of a whip," or the "snap of a gun," and the disease has then developed gradually. In the traumatic cases, the blow upon the head has usually been severe, attended in some instances with symptoms of fracture of the anterior part of the base of the skull. In several cases it has arisen from penetrating wounds of the orbit caused by sticks or small shot.

Of the 73 cases collected by Rivington, 32 were idiopathic and 41 traumatic. Of the idiopathic cases two were congenital, probably genuine specimens of cirsoid aneurism ; the mean age of the rest was 43, the oldest being 69. The mean age of the traumatic cases was between 30 and 31, the extremes being 11 and 72. The spontaneous cases were most commonly in women : thus, of 30 cases in which the sex is recorded, 21 were females. The traumatic form is most common in men, the number being 31 males to 10 females. Amongst the idiopathic cases 15 occurred on the right side, 13 on the left, and 2 on both sides ; of 40 traumatic cases, 10 were on the right, 27 on the left, and 3 on both.

Symptoms.—The first sensation experienced is, in spontaneous cases, that of a loud snap or crack in the orbit or head. This is followed by congestion of the conjunctiva, difficulty in opening the eyelids, a feeling of tension, and in some instances severe pain in and around the orbit. Loud whizzing bewildering noises are experienced in the head, and are much increased on stooping or lying down. In traumatic cases, a persistence of congestion of the conjunctiva with redness and some œdema of the eyelids, and the occurrence of noises in the head, are usually the first indications of the mischief that has occurred. In all cases, after a time, the eyeball becomes unduly prominent, and pulsation of a thrilling vibratory character can be felt in the orbit; on the application of the ear, a loud whizzing bruit is heard, which extends widely over the side of the head. The eyeball itself eventually falls into a state of chronic congestion; chemosis occurs, the cornea becomes opalescent, the aqueous humour turbid, and sight is impaired or lost. The bruit and pulsation are diminished or cease on compressing the carotid artery of the side affected.

Prognosis.—I think it is still doubtful what would happen in a large number of these cases, if the disease were left to itself without operation. It might be supposed that it would probably have a fatal termination; that rupture would take place either into the cranial cavity or externally, and that sudden death would occur. That this has occasionally taken place is proved by recorded cases, but it is by no means a necessary consequence of the disease. I was consulted at the end of 1865 by a gentleman about 44 years of age, who, in consequence of a fall on the head a few months previously, had been attacked with symptoms of aneurism of the left orbit in the most marked manner. The bruit and the pulsation were very loud and distinct. The eyeball was greatly protruded, the conjunctiva and eyelids were congested and swollen. Greaves of Burton, with whom I saw the case, agreed with me in urging ligature of the carotid artery as the only means of cure. To this the patient would not consent, and preferred taking his chance. By attention to habits of life, abstinence from stimulants, and ordinary medical treatment, the tumour subsided, the eye retreated within the orbit, and the symptoms diminished greatly; so that, at the end of fourteen months from the time when I first saw him, I understand that they had to a very great extent disappeared. In fact there is reason to believe that all the signs of intraorbital aneurism may entirely disappear, the disease undergoing a spontaneous cure. Collard relates the case of a man 41 years of age, who, in consequence of a fall on the back of his head by which he was rendered insensible, was gradually seized with symptoms of aneurism of the left orbit; bruit, pulsation, diplopia, and protrusion of the eyeball, together with congestion of the eyelids, being most marked. After the disease had continued for a considerable length of time, the patient was put upon a course of purgatives, with a calomel and belladonna pill daily, and cold lotions to the forehead. Under this treatment the symptoms gradually subsided, and in three years and a half from the commencement of the disease had entirely disappeared. Collard believes that in this case there was a dilatation of the ophthalmic artery and its branches, arising from and maintained by a morbid state of the ophthalmic ganglion, which furnishes vaso-motor filaments to the arteries of the eye. This ganglion he believes to have been injured by *contrecoup*, and to have remained in an abnormal state, which produced dilatation of the wall of the ophthalmic artery and its branches, increase of the pulsations and the other symptoms which have been described above. It is evident from these cases that a grave prognosis should not be hastily given, as it is only by watching the case that a correct conclusion can be arrived at. If the protrusion of the eyeball continues to increase, and the globe itself begins to suffer, and vision is lost, the prognosis becomes grave and the case is one requiring surgical treatment. If there is no increase of the symptoms after some months' observation, the patient may be left to nature unless the annoyance of the disease is so great that an attempt to give relief becomes necessary.

Pathology.—The essential features of so-called intraorbital aneurism or pulsating tumour of the orbit, may arise from more than one pathological condition. Rivington has collected 12 fatal cases in which the diseased parts were examined after death. In one only (Guthrie) was an aneurism found in the orbit. In this case the disease was double, and there was a circumscribed aneurism on each ophthalmic artery. In three cases no arterial disease was found : in one of these (Œtlingen) there was obliteration of some of the veins of the orbit from old inflammatory mischief, in the other two (Bowman and Aubrey) there was obstruction to the passage of blood from the orbit through thrombosis of the intracranial sinuses. In one (Nunneley) there was a circumscribed aneurism of the ophthalmic artery before it entered the orbit; in three (Baron, Gendrin, and Nunneley) rupture of an aneurism of the internal carotid into the cavernous sinus was found : in one (Wecker) simple dilatation of the carotid in the cavernous sinus was the cause of the disease, and in the remaining three, recorded by Delens, an aneurismal varix of the carotid artery and cavernous sinus was found. These three were all the result of injury, one arising from a direct wound from the point of an umbrella thrust into the opposite orbit, and the other two from severe blows on the head, probably accompanied by fracture. No case of aneurism by anastomosis of the orbit has been demonstrated by *post-mortem* examination, but there is strong reason to believe that two cases which have been recorded of congenital origin were of this nature. The earlier observers supposed all cases to be due to aneurism by anastomosis. The fallacy of this opinion was first pointed out by Busk, who referred the symptoms to a rupture of the ophthalmic artery and the development of a circumscribed traumatic aneurism of that vessel ; this also has not been demonstrated by *post-mortem* observation. Nunneley doubted the correctness of this view, and referred the symptoms, in some cases, to a peculiar vascular condition of the parts, dependent more upon an affection of the veins than the arteries, and somewhat analogous to what takes place in the exophthalmos of bronchocele. He pointed out also that although in other cases an aneurism exists, it is not in the orbit, but behind it in the cavernous sinus. In these latter cases he showed that the prominence of the eyeball is due to distension of the veins of the orbit from obstruction to the return of blood, and the pulsation is communicated to these distended veins by the aneurism in the cavernous sinus. This view is fully confirmed by the *post-mortem* records quoted above. In those cases in which nothing beyond obstruction to the return of blood through the cavernous sinus and consequent dilatation of the orbital veins has been found, the cause of the pulsation is not so evident. In other cases it is perhaps possible that some derangement of the vaso-motor influence of the sympathetic may really occasion the symptoms of increased vascular activity that are so characteristic of the disease.

The secondary phenomena that are observed in these cases, such as congestion of the eyelids, of the palpebral and ocular conjunctivæ, amounting even to chemosis in many cases, and the muddiness of the aqueous humour and lens, are doubtless due to an interference with the return of blood from these parts through the ophthalmic vein, and to the consequent congestion of the smaller vessels and effusion of serum. The protrusion of the eyeball is due to the vascular tumour, whatever its precise nature may be, and the derangement in vision to an alteration in the axis of the eye consequent on this extrusion. It is remarkable that the bruit in these cases should be so loud, not only to the patient's own senses, but to the ear of the Surgeon; and this can be accounted for only by the proximity of the cranial bones, which may act as conductors of sound.

Diagnosis.—The *Diagnosis* of pulsating tumour is sufficiently easy, but it is just as difficult to determine accurately the cause of the disease. It is probable that nearly all the traumatic cases are due to aneurismal varix of the carotid artery and cavernous sinus. The sudden onset of the disease with a crack or snap in idiopathic cases, would lead to a presumption that a small aneurism of the carotid had given way into the sinus. Congenital cases are probably aneurisms by anastomosis. Beyond this, accurate diagnosis of the pathological condition is hardly possible. The disease most likely to be mistaken for an intraorbital aneurism is a pulsating sarcoma of the bones of the orbit. In this, however, the pulsation is less expansile and the peculiar harsh bruit is wanting.

Treatment.—The results of the cases that have been referred to above, the uncertainty in which we often are as to the real nature of the disease, and the certainty that in some instances at least there is no true aneurismal tumour, would justify the Surgeon in having recourse to medical treatment. aided by digital compression of the carotid, and, perhaps, the application of ice to the forehead, before proceeding to operate. That these means are occasionally successful, there can be no doubt. Gioppi, of Padua, has recorded a case in which an intraorbital aneurism of great severity was cured by intermittent digital compression. The compression was kept up for periods of a minute or two with frequent intervals; pressure continued for more than one minute caused fainting. The disease was cured in four days. Vanzetti and Scarramuzza have published another case, in which intermittent digital compression was kept up for five minutes at a time. The case was completely cured at the end of compression during seven hours and twenty minutes, spread over eighteen days.

Among the cases collected by Rivington were 16, including those just mentioned, in which digital compression was adopted. Of these, 5 were idiopathic and 11 traumatic. Two of the former and one of the latter were cured; in the rest no benefit resulted from the treatment. Instrumental compression was tried in four cases without result. Galvano-puncture was tried twice; once it failed and once it was fatal. Coagulating injections were used in four cases, in all of which the disease was traumatic. The substance used was perchloride of iron in three cases, two of which were cured and one derived no benefit. In the fourth case a solution of lactate of iron was injected and the patient was cured. In spite of this success the injection of coagulating fluids into a dilated vein in which it is impossible temporarily to arrest the flow of blood, can hardly be regarded as a safe proceeding. When medical treatment and compression have failed in producing a decided impression, the only course left is the application of a ligature to the common carotid of the side affected. This operation has been highly successful. Rivington has collected 44 cases in which it has been performed, 18 idiopathic and 26 traumatic. Of the idiopathic cases 3 died and 15 recovered; of these 15, 12 were cured, in 8 vision was restored, in 3 it was not regained, and in one the effect in this respect is not mentioned. The remaining 3 cases were benefited by the operation. Of the 26 traumatic cases, 3 died and 23 recovered. Of the 23, 14 were cured, 1 by subsequent injection. Vision was not regained in 4. In 5 the operation failed, and 2 of these were subsequently cured by ligature of the opposite artery. Four were partially cured and one relapsed after apparent cure.

In a very interesting case which I saw in Velpeau's wards in 1839, both orbits were affected; and, as pressure on the right carotid arrested the pulsation and bruit in both, that artery was tied. But though the disease was cured in the left orbit by this operation, and temporarily arrested in the right, it reappeared in the latter situation, and was eventually cured there by the ligature of the left carotid.

ANEURISM OF THE SUBCLAVIAN ARTERY.

Aneurisms of the Subclavian occur in order of frequency between those of the carotid and of the brachio-cephalic arteries. They are most often met with on the right side, in the proportion of about three to one; and this would appear to be in a great measure dependent on their being occasioned by direct violence, or by repeated or prolonged exertion of the arm; thus they commonly occur from falls, blows upon the shoulder, or excessive fatigue of this extremity. From the fact of the aneurisms arising from external violence, we should expect to meet with them most frequently in males, and this we do in a remarkable manner. Of 120 cases collected by Poland, only 11 occurred in females, and in 4 of these instances the disease resulted from injury; in 2 cases, both arteries were affected. The disease may be seated in any part of the vessel on the right side, though most commonly it is not dilated until after it has passed beyond the anterior scalenus. On the left side aneurism never occurs before the artery has emerged from the thorax; and then, as on the right, it most commonly happens in the third part of the vessel. Subclavian aneurism may occur at any age above 21. It is most common in middle life; and, according to Poland, is three times more frequent in England than in any other country.

Symptoms.—An aneurism of the subclavian artery is characterized by a pulsating compressible tumour of an elongated or ovoid shape, situated at the base of the posterior inferior triangle of the neck, immediately above the clavicle. If it be small, it will disappear behind this bone on the shoulder being raised; as it increases in size, it fills up the whole of the space above the clavicle between the sterno-mastoid and the trapezius, often attaining a very considerable bulk. In consequence of the pressure which it exercises on the brachial plexus of nerves there is pain, often attended by numbness, and extending down the arm and fingers, usually with some weakness of these parts. In some instances there is a spasmodic affection of the diaphragm, owing to irritation of the phrenic nerve. The external jugular vein is commonly distended and varicose; œdema of the hand and arm may be present. The tumour does not increase rapidly in size, owing to its being tightly compressed by the surrounding parts; and, as the disease never extends inwards, it does not interfere with the trachea or œsophagus. In some cases it has been known to extend downwards and backwards, so as to implicate the pleura and the summit of the lung.

Diagnosis.—The diagnosis of subclavian aneurism is usually easy, and presents no point of a special character. Mayo, however, mentions a case in which an exostosis of the first rib pushed forward the subclavian artery in such a way as to cause it to simulate an aneurism, and eventually to arrest the pulsation in it.

Results.—As a subclavian aneurism increases in size, it may become diffused, and burst either externally or into the pleural sac. A spontaneous cure has more frequently occurred in this than in any other external aneurism.

Treatment.—The treatment of subclavian aneurism is in the highest degree unsatisfactory. *Compression on the cardiac side* can be employed only when the artery is so irregularly distributed that it rises sufficiently high in the neck to admit of pressure being applied between the scalenus and the sac. Such a combination of irregular anatomical distribution with aneurism must of necessity be excessively rare; but in one case in which it occurred, Poland succeeded in effecting a cure by digital compression kept up for ninety-six hours. The tumour was then smaller and harder, but still pulsated. The patient left the Hospital, and, at the end of a month, the tumour was found to have become solid, and to have ceased to pulsate. The number of cases in which compression is possible may perhaps be increased by performing the operation under prolonged anæsthesia.

Direct Pressure on the sac has been tried in three cases, and in all successfully. Warren of Boston made the pressure by means of a weight; and Corner of Poplar, by means of a leathern cup moulded to the swelling. The attempts at obtaining consolidation of the tumour by *constitutional means*, have hitherto failed, except in some very rare instances. A case is reported by Yeatman of the cure of subclavian aneurism by Valsalva's plan in eighteen months. *Galvano-puncture* has been tried five times, but only once with success—in a case under the care of Abeille. Three cases have been successfully treated by Langenbeck of Berlin, and one by Dutoit of Berne, by the *subcutaneous injection of ergotin* into the integuments over the tumour. *Manipulation*, as recommended by Fergusson, has been tried five times (Holmes): once in the hands of Little successfully, once by Fergusson with partial success, and in the three remaining cases without any advantage. The treatment deserves a further trial in these cases, when we consider the extreme danger of the disease and the great want of success that attends other means of cure.

Ligature of the brachio-cephalic, and of the subclavian itself, internal to, behind, and beyond the scalenus anticus, has been practised for the cure of this form of aneurism; it has likewise been proposed to apply the distal operation to the treatment of this disease, and to amputate at the shoulder-joint.

When an aneurism is situated on the right subclavian artery on the tracheal side of the scalenus, there is no way in which the flow of blood through it can be arrested, except by the ligature of the brachio-cephalic artery. When it is situated beyond the scalenus, or even behind it, ligature of the vessel has been practised in the first part of its course before it reaches this muscle. For subclavian aneurism on the left side, in these situations, no operation conducted on the Hunterian principle would be practicable.

Let us now proceed to examine the results that have attended these operative procedures.

Ligature of the Brachio-Cephalic.—The brachio-cephalic artery, as may be seen by the accompanying table, has been ligatured at least seventeen times.

CASES OF LIGATURE OF BRACHIO-CEPHALIC ARTERY.

OPERATOR.	SEX.	AGE.	NATURE OF DISEASE.	RESULT.	REMARKS.
1. Mott.	m.	57	Subclavian aneurism.	Died on 26th day.	Tied an inch below bifurcation. Ligature separated in fourteen days. Hæmorrhage on 23rd day, stopped by pressure: recurred on 26th.
2. Gräfe.	m.	abt. 30	Subclavian aneurism.	Died on 68th day.	Ligature separated in fourteen days. Hæmorrhage after separation of ligature arrested by cold and pressure, and did not recur. Suppuration of sac: incision. Hæmoptysis and fever. Death without further hæmorrhage. Artery safely occluded.
3. Hall.	m.	52	Subclavian aneurism.	Died on 5th day.	Artery was diseased and gave way. Bleeding arrested by plug: death from other causes.
4. A Surgeon in Paris.	...	...	... ...	Died.	Case referred to by Dupuytren.
5. Norman.	m.	...	Subclavian aneurism.	Died.	Died of pericarditis sixty hours after operation.
6. Bland.	m.	31	Subclavian aneurism.	Died on 18th day.	Hæmorrhage from distal side came on on the 17th and 18th days. Ligature applied to upper portion of artery.
7. Lizars.	m.	30	Subclavian aneurism.	Died on 21st day.	Ligature separated on 17th day. Hæmorrhage on 19th. Pleurisy of right side.
8. Hutin.	m.	26	Hæmorrhage from axilla after ligature of subclavian.	Died in 12 hours.	Punctured wound in axilla, for which subclavian was tied; secondary hæmorrhage, and then brachio-cephalic tied.
9. Arendt.	m.	36	Subclavian aneurism.	Died on 8th day.	Inflammation of lung, pleura, and aneurismal sac.
10. Cooper. (San Francisco.)	m.	...	Subclavian and carotid aneurism.	Died on 9th day.	Upper end of sternum and inner end of clavicle removed. Dyspnœa and retention of urine: pus in the right kidney.
11. Cooper. (Do.)	m.	...	Subclavian and carotid aneurism.	Died on 34th day.	Bones removed as in previous case. Patient was apparently doing well, when secondary hæmorrhage appeared. Immediate cause of death, hæmorrhage, in consequence of removal of bandages by patient.
12. Gore. (Bath.)	m.	52	Subclavian and axillary aneurism.	Died on 17th day.	Artery partially cut through by ligature. Cardiac extremity not contracted, but partially plugged with dark coagulum. Inflammation of subclavian vein (left). Pus in anterior mediastinum. Aneurism contracted and filled with coagulum.

CASES OF LIGATURE OF BRACHIO-CEPHALIC ARTERY—(*continued.*)

OPERATOR.	SEX.	AGE.	NATURE OF DISEASE.	RESULT.	REMARKS.
13. SMYTH. (New Orleans.)	m.	32	Subclavian aneurism.	Recovery.	Ligature applied to brachio-cephalic a quarter of an inch below bifurcation, and at same time to carotid one inch above origin. Hæmorrhage on 15th, 33rd, and 51st days, arrested by pouring shot into the wound. Ligature of right vertebral on 54th day. Tumour returned ten years afterwards and proved fatal.
14. BICKERSTETH. (Liverpool.)	m.	40	Subclavian aneurism.	Died on 6th day.	Direct compression tried on the artery for two days. Then ligatured above and below the spot where compression had been applied. Death from hæmorrhage from the distal side.
15. O'GRADY. (Dublin.)	...	...	Subclavian aneurism.	Death next day.	Carotid also tied. Apoplectic symptoms.
16. W. THOMSON. (Dublin.)	m.	49	Subclavian aneurism.	Died on 42nd day.	Secondary hæmorrhage 30th and 39th days. The hæmorrhage came from an opening in the artery, the result of ulceration. It was one quarter of an inch above the seat of ligature. An ox-aorta ligature was used. No trace of it was found at the *post-mortem*.
17. BENNETT MAY.	m.	30	Subclavian aneurism.	Died on 18th day.	Secondary hæmorrhage from ulceration opposite the knot of the ligature. Twisted strands of catgut used after breaking of an ox-aorta ligature; coats not divided.

In addition to the above seventeen cases, in which I have been able to refer to the original records, the artery is said to have been tied by Lynch for secondary hæmorrhage after a gunshot wound, the patient dying of hæmorrhage on the 12th day; by Partridge of Calcutta, for secondary hæmorrhage after ligature of the carotid, the patient dying in a few hours; by Pirogoff in a case of subclavian aneurism, the patient dying in 48 hours from diffuse inflammation of the sheath of the artery, pleurisy and pneumonia; and twice by Bugalski, both fatal. In the Index Catalogue of the Library of the Surgeon-General's Office, Washington, is a reference to a paper by D. L. Rogers on "A case of successful ligation of the innominate artery," but I have found no mention of this case elsewhere, and have not been able to refer to the original paper. The artery was cut down upon, but not actually ligatured by Porter, Post, Aston Key, Hoffmann and Peixoto.

As will be seen from the above table, there is only one recorded case of recovery after ligature of the innominate artery, and in every instance but one with a fatal result. In four other instances the operation has been commenced, but abandoned owing to unforeseen difficulties, and this by some of the most skilful operators that their respective countries can boast of.

Although, in reasoning on the propriety of performing an operation, it is not in general worth while to take into consideration the difficulties that the Surgeon may encounter, provided the operation be at last practicable; yet, when we consider the fact of this operation having been left unfinished in consequence of insurmountable difficulties in so large a proportion of the cases, and these in the hands of Surgeons who were well able to accomplish whatever was within the limits of possibility, we may well hesitate to undertake so serious a proceeding. The difficulties to which I have alluded do not consist merely in the position and anatomical relations of the vessel, but rather in the condition in which the artery and the adjacent structures may be found after the vessel is exposed. Thus, in Porter's case, the aneurism, which was a large one, occupied the whole of the inferior posterior triangle of the neck, being nearly six inches broad ; as no pulsation was traceable in the vessels beyond the aneurism, it was useless to attempt ligature on the distal side. On exposing the brachio-cephalic, that vessel was found to be diseased, and it was not thought desirable to pass the ligature round it. In consequence of the exposure of the artery, however, the pulsation of the tumour gradually diminished, and at last ceased entirely, its bulk also becoming less. In Key's case, in which it was impracticable to pass the ligature, it was found after death that the brachio-cephalic was diseased, being dilated immediately after its origin into an oblong tumour, which occupied the whole of the artery. It is remarkable that in this case, as in Porter's, inflammation seems to have taken place in the artery in consequence of the necessary handling to which it was subjected, and that the pulsation in the sac consequently diminished.

The difficulties of the operation are in themselves considerable ; arising from the depth of the vessel, from its proximity to the heart, and from the neighbourhood of large veins, which may become turgid, and a wound of which not only obscures the incision with venous blood, but is accompanied by the danger of entrance of air into the circulation. The trunk of the artery lies behind the sterno-clavicular articulation and the upper part of the sternum, and bifurcates at the level of the upper border of the clavicle. In front of it are the sterno-hyoid and sterno-thyroid muscles, and it is crossed near its upper part by the right inferior thyroid vein, and lower down by the left innominate. To the right side is the right innominate vein. The pneumogastric nerve is behind and to the outer side, not being in close relation with the artery. Behind the vessel are, at first the trachea, then the pleura, the trachea being now internal to the artery. The artery may be reached in the dead body by an incision starting from the sterno-clavicular articulation, and carried upwards for about three inches between the two heads of the sterno-mastoid, but this would not be justifiable in the living subject, as it does not give sufficient space. The early steps of the operation should be the same as in ligature of the lower part of the carotid (see Ligature of the Carotid, p. 175). The sterno-hyoid and sterno-thyroid muscles must be freely divided, and the carotid exposed as low down as possible. This vessel serves as the guide to the innominate, the finger being passed along it till the bifurcation of the main trunk can be felt. The needle is then guided by the finger, and passed round the artery from the outer side. It is evident that the vessel cannot be clearly exposed in this mode of operating, and the needle is therefore passed somewhat in the dark. To overcome this difficulty, Cooper removed the inner end of the clavicle and part of the sternum in both his cases, and should the operation be repeated it is probable that this would be the safest plan of exposing the vessel; at any rate the operator should be prepared to adopt it as an extension of the proceeding first described if necessary. Even when the difficulties of exposing the artery have been surmounted its coats may be found so diseased, or its calibre so increased, that it may be undesirable or impossible to pass a ligature round it. The failure in deligating the artery would, however, as we shall immediately see, appear to be less disastrous in its consequences than success; for of the three cases that have just been referred to, in which this attempt was made and did not succeed, one was cured of the disease, the artery being obliterated by thrombosis, consequent upon inflammation of its coats, set up by the manipulation during the operation; and in another, Key's patient, an attempt to set up this process appears to have been made, the tumour becoming solid and ceasing to pulsate; whereas, in every case but one in which the vessel has been ligatured, a fatal result has speedily ensued.

The results of the ligature of the vessel are then in the highest degree discouraging; for of all the cases in which it has been done, only one has recovered. Of the cases recorded in the table nine died of secondary hæmorrhage: one from inflammation of the lungs or pleura, one from pericarditis, one from diseased kidney, one from phlebitis and suppuration, one from "apoplectic symptoms," and three from causes that are not mentioned.

In one case, that of Hall, the artery was transfixed by the aneurism-needle; hæmorrhage occurred at the time, which was arrested by plugging, and did not recur, the patient dying from other causes. In three cases, those of Mott, Bland, and Lizars, the hæmorrhage came on shortly after the separation of the ligature; but in Gräfe's it did not occur for fifty-one days after this, the cicatrix in the artery having then probably given way under the influence of some imprudent movement on the part of the patient. In Cooper's second case the patient appeared to be going on well for some weeks, when secondary hæmorrhage appeared. Learning that nothing further could be done, the patient tore off the bandages when alone, and bled to death. In Bickersteth's case, the artery had been injured by the previous compression applied by means of a leaden wire. The ligature was applied on each side of the bruised spot; but secondary hæmorrhage proved fatal on the sixth day. With such results as these, there can be but one opinion as to the extreme danger of such an operation. Thompson's case was the first in which a ligature not intended to cut through the coats of the artery has been applied. The material used was the ox-aorta ligature recommended by Barwell. Although the patient died from secondary hæmorrhage on the forty-second day, the result was to some degree encouraging, for the blood had escaped from an ulcerated opening at the bifurcation, and not from the seat of ligature. The opening seems to have been the result of ulceration from a small cavity left after partial healing of the wound, and it seems probable that the blood was supplied by a recurrent stream through the vertebral. In Bennett May's case the ox-aorta ligature broke, and as a substitute several strands of catgut twisted together were used. Ulceration took place opposite the knot of the ligature, and death occurred from secondary hæmorrhage. The only successful case, that in which Smyth of New Orleans was the operator, is one of the most remarkable on record, but in reality affords no evidence as to the possibility of safely ligaturing the brachio-cephalic trunk. For in this case the carotid was also tied so as to stop the regurgitant flow of blood; yet, notwithstanding this precaution, on the fourteenth day severe hæmorrhage to syncope occurred. This hæmorrhage recurred at intervals for a period of thirty-seven days, and was temporarily arrested by filling the wound with shot, till, on the fifty-first day after the operation, a "terrific" hæmorrhage took place, stopped by syncope. As this bleeding came from the distal side and from the subclavian artery, the vertebral was tied, with perfect success—no bleeding recurring. This fact is of the utmost surgical value ; it shows that the secondary hæmorrhage, which may be looked upon almost as the necessary sequence of the ligature of the innominate artery, may be arrested and the patient's life saved by the ligature of the principal arterial branch that communicates with and that carries regurgitant blood into the distal end of the artery which was originally ligatured. This fact is entirely new in operative surgery ; and the establishment of it, as well as the skill and courage that were displayed in the operative procedures required in, and the general management of this case, reflect the highest credit on Smyth. I am indebted to him for the further history of this unique case. After ten years of good health, in which the patient was able to follow his employment as a ship's steward, the pulsation returned and the tumour reached a size larger than before. Thinking it might be fed by the internal mammary, Smyth ligatured that vessel, but without result. About six months after an abscess formed over the sac, and the aneurism became diffused into it, and as a last effort to save the patient's life, Smyth performed the heroic operation of laying open the sac. The hæmorrhage was profuse, and the openings of the vessels into the sac could not be seen, so that the operator had to content himself with plugging the wound. The patient died a few days after. The *post-mortem* examination showed that the circulation had been carried on chiefly by means of the aortic intercostals and branches of the axillary artery. As, therefore, the operation has hitherto been fatal in every case but one, it should without doubt be undertaken with much hesitation, and only as a last resource.

Ligature of the Subclavian in the Third Part of its Course is rarely practicable in cases of subclavian aneurism, as this part of the vessel is more or less completely covered by the sac. Poland has, however, collected twenty-one cases in which this operation has been performed for subclavian or subclavio-axillary aneurism. Of these nine recovered. The sac was punctured in two cases—by Liston and Travers. The majority of the deaths were from hæmorrhage. Warren relates a remarkable case occurring in a lady aged thirty, who was afflicted by an aneurism just above the clavicle. The patient was excessively deformed from club-foot and curvature of the spine, so that the two first ribs rose above the clavicle, passing obliquely across the neck and carrying the artery upwards and backwards, so that it lay parallel to, and about an inch from, the external border of the trapezius. This peculiarity of position enabled Warren to tie the artery on the cardiac side of the tumour, and the case had a successful issue.

Ligature of the First Part of the Subclavian has been performed for aneurisms situated on the right subclavian artery, behind or beyond the scalenus. When we consider the anatomical relations of that portion of the right subclavian which intervenes between the brachio-cephalic artery and the tracheal edge of the scalenus anticus muscle, we are at once struck with the great difficulties of this undertaking ; and when we reflect on the position in which the ligature will be placed between the onward current of blood in the brachio-cephalic on the one side, and the regurgitant stream conveyed by the vertebral, the thyroid axis, the internal mammary and superior intercostal, into the subclavian, immediately beyond the seat of deligation on the other side, we can scarcely anticipate any but the most disastrous results, unless the vessel can be successfully occluded without dividing its coats.

With reference to the mere difficulties of the operation, Fergusson justly characterizes it as the most serious in Surgery ; the proximity of the common carotid artery on one side, the internal jugular vein on the other, the innominate vein below, the vagus and numerous small venous trunks in front, the recurrent laryngeal nerve and pleura behind, constitute relations of sufficient importance to justify Fergusson's opinion. But supposing these difficulties overcome, and the ligature applied, this must be situated, as has just been stated, in such a position, with a strong current of blood flowing upon each side of it, as to render the formation of an internal coagulum impossible, and thus up to the present time secondary hæmorrhage has invariably occurred when the ligature separated. Whether the application of an absorbable ligature without division of the coats of the artery will be more successful remains to be seen. Besides the danger of secondary hæmorrhage from these causes, there would be the additional risk of the coats of the artery being diseased, as we commonly find them to be in a more or less morbid state in the immediate vicinity of aneurisms ; and, thus being rendered insusceptible of healthy repair, ulceration and sloughing would take place along the track of the ligature, causing the probability of a recurrence of hæmorrhage. Thus, in Colles's case it was seen on exposing the subclavian artery, that the aneurism had extended in such a way towards the carotid, that it was doubtful whether any part of the affected vessel continued sound. On exposing fully, it was found that only a space of the vessel three lines in length remained free between the sac and the bifurcation of the brachio-cephalic, and it was in this narrow space that the ligature was applied.

The right subclavian has been ligatured on the tracheal side of the scalenus in fourteen cases, all of which proved fatal : twelve from hæmorrhage, one from inflammation of the pericardium and pleura, and one from pyæmia.

The cases are as follow :—

SURGEON.	SEX.	AGE.	DATE OF DEATH.	CAUSE OF DEATH.
COLLES.	m.	33	4th day.	Hæmorrhage.
MOTT.	f.	21	18th day.	Hæmorrhage.
HAYDEN.	f.	57	12th day.	Hæmorrhage.
O'REILLY.	m.	39	13th day.	Hæmorrhage.
PARTRIDGE.	m.	38	4th day.	Pericarditis and pleurisy.
LISTON.*	m.	...	13th day.	Hæmorrhage.
LISTON.†	m.	...	36th day.	Hæmorrhage.
CUVILLIER.‡	m.	...	10th day.	Hæmorrhage.
RODGERS.	m.	42	14th day.	Hæmorrhage.
AUVERT.§	...	...	11th day.	Hæmorrhage.
AUVERT.§	...	...	22nd day.	Hæmorrhage.
ARNDT.	m.	34	5th day.	Pyæmia.
BAYER.	m.	21	24 hours.	Hæmorrhage.
HOBART.‡	f.	...	16th day.	Hæmorrhage from the carotid.

Thus it will be seen that, while the operation is bad in principle, it is most

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In this case the carotid was also tied, but the hæmorrhage came from the subclavian (Fig. 481).

† Fig. 480.

‡ Carotid also tied.

§ Referred to by J. H. Power.

unfortunate in practice. This appalling Table needs no comment. It is, to my mind, conclusive as to the merits of the operation, the patient having, in every case but two, been carried off by secondary hæmorrhage from the distal side of the ligature, in consequence of the close proximity of numerous collateral branches (Fig. 480); and in the two exceptional cases the operation, although performed skilfully, proved fatal in one instance from pericarditis and pleurisy, and in the other from pyæmia, before the period at which secondary hæmorrhage might have been expected. Liston, in one case, ligatured the root of the common carotid, as well as that of the subclavian, hoping in this way to diminish the risk of secondary hæmorrhage, by arresting the current of blood which, by sweeping into the carotid past the mouth of the subclavian, would necessarily wash away any coagulum that might be formed in this artery. But his expectations were not realised; hæmorrhage took place as usual, and from that portion of the artery which lay on the distal side of the ligature, the blood having been carried into this end of the vessel in a retrograde course, through the connection existing between the vessels arising from it at this point, and those on the opposite side of the head and neck, as illustrated by the annexed cut (Fig. 481), taken from the preparation of the case in the University College museum. Indeed, this is the great danger to be apprehended after ligature of the subclavian artery on the tracheal side of the scalenus, depending as it does on the anatomical relations and connections of the vessel, which no skill on the part of the operator can in any way lessen, and which, in my opinion, ought certainly to cause the operation of ligature of the subclavian in the first part of its course to be banished from surgical practice, unless further experience shows that absorbable ligatures can be applied with certainty in such a way as to occlude the artery without risk of ulceration or division of its coats.

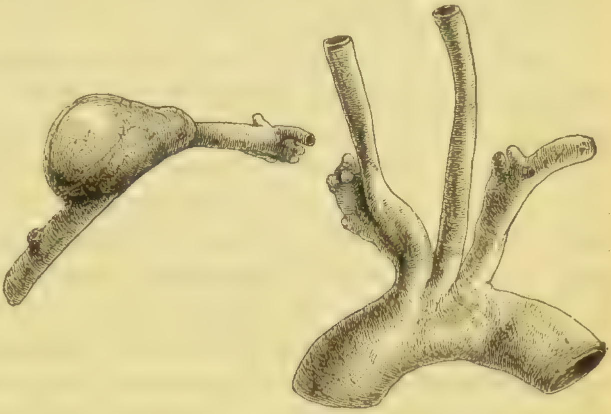


Fig. 480.—Ligature of the Subclavian in the First Part of its Course, by Liston.

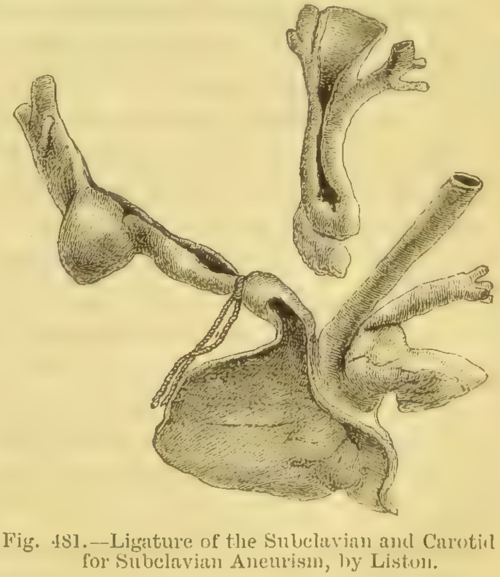


Fig. 481.—Ligature of the Subclavian and Carotid for Subclavian Aneurism, by Liston.

The method of operating that has been most commonly adopted is the same as that already described for ligature of the root of the carotid. When the vessels are exposed, the jugular vein is drawn outwards with a copper spatula, and the subclavian is thus brought into view. The needle is passed from below upwards.

Ligature of the First Part of the Left Subclavian is scarcely practicable, on account of the depth at which the artery is situated. It has, however, been performed in one case by Dr. J. R. Rodgers of New York; and it was attempted once by Sir Astley Cooper, who failed to secure the vessel, and is said to have wounded the thoracic duct. In another case McGill exposed the artery, and temporarily compressed it with a pair of forceps. The pleura was wounded in the operation, and the patient died on the sixth day of pleurisy.

Thus it will be seen that, in every case, except Smyth's, in which an aneurism of the subclavian artery has been subjected to operation, whether by ligature of the brachio-cephalic or of the subclavian itself *internal* to the scaleni, the result has been a fatal one. As this unfortunate termination is in no way to be attributed to want of skill on the part of the operators,—who have been, without exception, men greatly distinguished for the possession of this very quality,—but is dependent solely on certain anatomical peculiarities in the arrangement of these vessels, by which their successful ligature has been rendered all but impossible, a repetition of these attempts can hardly be recommended. What then are we to do? Are we to leave patients labouring under aneurism of the subclavian artery to inevitable death, without making an effort to save them? Or does surgery offer other modes of treatment besides those just mentioned, by which we may hope to arrive at more successful results?

Without mentioning direct pressure, manipulation, or galvano-puncture, which are certainly deserving of further trials in combination with appropriate constitutional treatment, three modes of treatment present themselves:—

1. Compression of the Artery where it passes over the First Rib, and consequently on the Distal side of the Tumour.
2. Ligature of it on the Distal Side, above or below the Clavicle.
3. Amputation at the Shoulder-joint, and Distal Ligature of the Artery.

1. **Compression of the Artery on the Distal Side of the Sac** could be effected only where it crosses the first rib, and consequently would be applicable only to those rare cases in which the aneurism springs from the first part of this vessel. This plan has never been tried: partly, perhaps, on account of the difficulty in applying pressure in this situation, and partly, probably, on account of the want of success that has attended procedures of this kind when applied to vessels in other situations.

The difficulty in applying the compression might, I think, be overcome by the use of an instrument of which a representation is given by Bourgery. The efficiency of the compression would be materially increased by the employment of direct pressure on the tumour, or of galvano-puncture or acupuncture at the same time, and in this way a coagulum might be formed in the sac. Although too much ought not to be expected from this mode of treatment, yet I think it might with propriety be tried in cases of the kind that has been mentioned.

2. **Distal Ligature of the Subclavian Artery in the Third Part of its Course** has been suggested, and may, perhaps, hold out some prospect of success in cases of aneurism situated behind or internal to the scalenus. In an aneurismal sac springing from the artery in this situation, the principal current of blood would, in all probability, be that which is destined for the supply of the upper extremity. Some of the branches arising from the artery before

it has passed beyond the scalenus anticus would, doubtless, be more or less compressed, and thus obliterated by the tumour; or they might be obstructed by an extension of the laminated fibrin over their orifices. If, therefore, the supply to the upper extremity could be cut off, there might be a possibility of those changes taking place within the sac which are necessary for the obliteration of its cavity. The principal obstacles to this desirable result would necessarily be the transverse cervical and suprascapular arteries; which, being the two vessels that are more particularly destined to carry on the circulation in the upper extremity after the ligature of the subclavian, would necessarily, if not occluded, undergo dilatation, and thus continue to draw too large a current of blood through the sac for stratification of its contents to take place; and, if they were occluded, there would be danger of gangrene of the arm from insufficient vascular supply.

Dupuytren ligatured the axillary artery under the pectoral muscles for a case of subclavian aneurism, two arterial branches being divided in the incisions through the fat and areolar tissue; and the patient died on the ninth day. This operation could not be expected to succeed; for between the ligature and the sac are the large and numerous alar, acromial, and thoracic branches of the axillary artery, which would continue to be fed by a current sent through the tumour, and thus preclude the possibility of its contents being sufficiently stationary for cure to result. Laugier performed the distal operation in a supposed case of subclavian aneurism, which afterwards turned out to be one of the brachio-cephalic artery. In addition to Dupuytren's case, the operation has been done by Pétrequin, Schuh, and Canton, in all instances without benefit.

3. The above-mentioned difficulties are met by a plan of procedure, originally suggested, I believe, by Fergusson. It is **Amputation of the Arm at the Shoulder-joint,** followed by **Distal Ligature of the Artery**—a desperate undertaking, truly, but for a desperate disease, it must be remembered, and one that under ordinary surgical treatment is almost incurable.

The artery might be ligatured before the amputation. "It is known," says Fergusson, "that amputation at the shoulder-joint is generally a very successful operation; so far as this wound is concerned, then, there might be little to apprehend, but the effect on the tumour is not so easily foretold. Ligature of the axillary artery on the face of the stump might here be reckoned like Brasdor's operation; yet there is a vast difference, for in the latter case the same amount of blood which previously passed towards the upper extremity would still find its way down, and probably part of it would run through the sac; whereas were the member removed, as the same quantity would no longer be required in this direction, the tumour might possibly be much more under the control of pressure. The value of such a suggestion remains yet to be tested, however, and it would be futile to reason upon it at present. It might be a judicious venture first to tie the axillary under the clavicle; and then, if it were found that the aneurism still increased, amputation might be performed, either immediately before or after the separation of the ligature."

Were a case of aneurism of the subclavian artery internal to the scalenus to present itself to me, the plan that I should adopt would be, first, the employment of pressure on the vessel at the distal side of the tumour, if practicable; should this fail, I would, if the disease were situated behind or internal to the scalenus, ligature the artery in the third part of its course; and, did that not succeed in checking the increase of the aneurism, I would perform amputation at the shoulder-joint, as recommended by Fergusson. Should the aneurism occupy the artery after it has passed the scalenus, direct pressure on the sac holds out the best prospect of success. Should that fail, I would not attempt the ligature of the artery below the clavicle ; as it is an operation the result of which is most unsatisfactory, and would not prevent a large current through the sac for the supply of the collateral circulation of the arm ; but I would at once have recourse to amputation at the shoulder, and then ligature the vessel as near as possible to the sac. It is true that, even in this case, the ligature would be below the branches that are given off under the pectoral muscles ; but, as the arm would be removed, they could not undergo any dilatation for the supply of the collateral circulation of the upper extremity.

The first case in which this operation was performed, was by Spence in 1864. The patient lived for four years ; and, although the aneurism was not cured, the result afforded good promise of success for the future. For the first ten days after the operation, the pulsation was scarcely to be felt ; and when the patient left the hospital the tumour had diminished to one-third of its former size. The artery was tied in two places—where it was cut, and also just beyond the tumour. Before the patient's death—which probably arose from internal aneurism—the tumour had increased somewhat towards the chest. Since this Holden and Heath have performed the operation, but without success. In both cases, however, the aneurism was traumatic in its origin, and had attained a large size before amputation was practised. Hence the chances of consolidation and cure were materially lessened.

Ligature of the Vertebral Artery.—This bold and difficult operation was first performed on the living body by Smyth of New Orleans, who had recourse to it to check regurgitant hæmorrhage after ligature of the innominate for subclavian aneurism (p. 196). I will give the details of the operation in the words of Smyth.—"The head of the patient being thrown back and slightly turned to the left, an incision two inches in length was made along the posterior border of the sterno-mastoid muscle, commencing at the point where the external jugular vein crosses this muscle and terminating a little above the clavicle ; the edge of the muscle being exposed and drawn to the inner side, the prominent anterior tubercle of the transverse process of the sixth cervical vertebra was readily felt and taken for a guide. Immediately before this and in a vertical line with it lies the artery. A layer of fascia was now divided : some loose cellular tissue with lymphatics and the ascending cervical artery were pulled to the inner side ; and a separation was made between the scalenus anticus and longus colli muscles just below their insertion into the tubercle, when the artery and vein became visible ; the latter was drawn to the outer side (this is important), and the needle passed around the former from without inwards."

In 1881, W. Alexander of Liverpool suggested ligature of the vertebral as a means of curing or relieving epilepsy. He performed the operation in several cases at first with apparent benefit, but subsequent observation showed that the improvement was merely temporary. The operation was repeated in two cases by Watson Cheyne. The method of operating was that above described, and the results so far as the operation was concerned were satisfactory in the great majority of the cases.

ANEURISM OF THE AXILLARY ARTERY.

This artery, though less commonly the seat of aneurism than other large vessels, such as those of the ham, the groin, and the neck, yet is not unfrequently diseased. This is due chiefly to its situation, its proximity to the shoulder-joint causing it to be subjected to the very varied, extensive, and often forcible movements, of which that articulation is the seat. Amongst the most frequent causes of axillary aneurism, may be mentioned falls upon the shoulder or upon the outstretched hands, and in many cases the efforts made at reducing old standing dislocations, instances of which are recorded by Pelletan, Flaubert, Warren, and Gibson, the head of the bone in these cases having probably contracted adhesions to the artery. Axillary, like subclavian aneurism, occurs more commonly on the right than on the left side, and is met with in especial frequency among men; of 37 cases, only 3 occurred in women. I am acquainted with one case only in which both axillary arteries became aneurismal; it occurred to Furner of Brighton. In this remarkable case both axillary arteries became affected, an interval of about fifteen months intervening between the formation of the two aneurismal tumours; and the subclavian was ligatured on both sides successfully.

Symptoms.—In axillary aneurism there are three sets of symptoms, attention to which will usually enable the Surgeon to recognize the disease; these are, the existence of a tumour in the axilla, the pain that it occasions, and the affections to which it gives rise in the limb.

The precise situation at which an aneurism of the axillary artery presents externally, will depend upon whether it springs from that portion of the vessel that lies above, beneath, or below the lesser pectoral muscle. If from above, it will appear as a tumour seated immediately below the clavicle and occupying the triangular space between the upper margin of the lesser pectoral and that bone; if it be lower down, it will raise the anterior fold of the axilla, being prevented from extending much out of this space by the dense fascia that stretches across from one side to the other. The tumour, which is at first soft and compressible, has usually a whizzing bruit; and its pulsations, which are expansile, may be arrested by pressure upon the subclavian artery, where it passes over the first rib. It usually increases with great rapidity, owing to the little resistance opposed by the loose areolar tissue in this situation, and most commonly extends downwards and forwards, causing the hollow of the axilla to disappear. In some rare instances, however, the tumour has been known to take a direction upwards under the lesser pectoral, and into the areolar interval above that muscle, or even underneath the clavicle into the acromial angle between it and the trapezius. It is fortunately rare for an aneurism to take such a course, as it would present serious difficulty in the compression or ligature of the subclavian; and there is more than one instance on record, in which the sac has been punctured in the attempt to pass the needle round this vessel. When the aneurism is seated high up, it not unfrequently happens that the clavicle is pushed upwards by the pressure of the tumour beneath it—a complication of considerable moment in reference to the operation, the difficulties of which are greatly increased by it. The *pressure* of the tumour upon neighbouring parts may give rise to serious consequences; thus it may produce a carious state of the first and second ribs, and the compression of the brachial plexus will occasion pain and numbness in the upper extremity. The *affec-*

tions of the limb occasioned by the aneurism are diminution or extinction of the radial pulse, œdema, coldness, and loss of muscular power. In some cases the brachial artery beyond the tumour would appear to be obstructed, no pulsation being perceptible in it. Compression of the axillary vein may occasion œdema of the hand and arm, with some diminution in the temperature of the limb; and these symptoms, if the tumour attain a very large size, may amount even to indications of impending gangrene.

Diagnosis.—The diagnosis of axillary aneurism is usually readily made; there being but two diseases with which it can well be confounded, viz., chronic enlargement and suppuration in the glands of the axilla, and pulsating tumour of the bones in this region. From *glandular or other abscess*, the diagnosis is generally easy; but I have seen some cases in which, pulsation being communicated to their contents by the subjacent artery, it was somewhat difficult to distinguish the nature of the tumours. Here, however, the history of the case and its speedy progress to pointing will indicate its true nature. From *soft pulsating sarcomata of the head of the humerus*, the diagnosis is not always so easy; and there are at least two instances on record in which the subclavian artery has been ligatured for disease of this kind on the supposition of its being an aneurism. In these cases it has, however, generally been observed that the tumour first made its appearance on the fore part of the shoulder, and not in the usual situation of axillary aneurism; that it was from the first firm, smooth, elastic, but nearly incompressible; and that, although it presented distinct pulsation, there was no true bellows-sound, but rather a thrilling bruit perceptible in it. The most important diagnostic mark, perhaps, is the fact of these tumours forming a prominence in situations in which aneurisms of the axillary artery would not at first show themselves, as at the upper, outer, or anterior part of the shoulder. In more advanced stages, when the substance of the bone has undergone absorption, and its shell has become thin and expanded by the outward pressure of the tumour, there is often an egg-shell crackling on pressure, which is never met with in cases of aneurism.

Treatment.—I am not acquainted with any instance in which an aneurism of the axillary artery, not arising from wound or injury, has undergone spontaneous cure, or has been consolidated by constitutional treatment. Compression or ligature of the subclavian in the third part of its course is the only means of cure.

Axillary aneurisms are favourably situated for the employment of *digital compression.* By this means the subclavian can easily be commanded as it passes over the first rib. And the success of this treatment is likely to be great; first, because, the sac being usually large, a considerable quantity of the contained blood is well out of the current of the circulation, readily stagnates and may thus easily coagulate; and secondly, because the current of blood through the sac is proportionately small, and thus, if coagulation once begin, may easily be completely arrested. Digital compression, therefore, in my opinion, should always be had recourse to in the first instance. By this means, aided by rest and constitutional treatment, the progress of the tumour may be stayed, and possibly a consolidation of its contents and cure be effected. This occurred in a patient seventy-one years of age, in whom an axillary aneurism as large as a shaddock and of an actively progressing character was cured by intermittent digital pressure continued at intervals for between two and three weeks, during which time compression was kept up in all about twenty-three hours, the consolidation commencing on the third day of treatment after seven hours of pressure had been tried. Holmes mentions eight cases in which digital compression has been tried. Three of these, under the care of Ciniselli, Dutoit, and another Surgeon whose name is not mentioned, were of traumatic origin, and of these two were cured. The remaining five were idiopathic. Three of these, under Cooper Forster, Peatson, and Rizzoli, were cured. Two, under Turet and Vanzetti, failed. In Cooper Forster's case the compression was applied twice under chloroform; on one occasion for three and a quarter hours and on the other for eight hours. In Peatson's case the pressure was applied at intervals for a period of nearly three months. In Rizzoli's case the treatment lasted even longer, the cure not being complete for nearly six months. In this case the artery was so dilated and diseased that ligature was impossible. In Dutoit's case the compression was applied for six hours a day for six days. Lund has also recorded a case cured by digital compression in two periods, the first of ten and the second of seven and a half hours. In another case under the care of S. Jones, compression was combined with the application of Esmarch's bandage to the arm, but without success.

Compression by instruments on the cardiac side can seldom be made applicable to aneurisms in this situation; inasmuch as the pressure that is brought to bear upon the subclavian must necessarily at the same time influence the greater part of the brachial plexus of nerves to such an extent as to be unendurable by the patient. Yet it is not impracticable, and means might be devised to overcome this difficulty.

Ligature of the artery is, however, still the Surgeon's chief resource in the treatment of these cases. The part of the vessel universally selected for the application of the ligature is that which lies on the first rib beyond the scalenus anticus muscle; this part presenting the advantages of being sufficiently removed from the seat of disease to ensure the probability of the coats of the artery being in a sound state, of being by far the most accessible, and, when deligated, of allowing the collateral circulation by which the vitality of the arm is to be maintained to remain uninjured.

Ligature of the Subclavian in the Third Part of its Course.—In order to apply a ligature to that portion of the subclavian artery which intervenes between the outer edge of the scalenus anticus and the lower border of the first rib, the patient should be placed in the recumbent position, the arm depressed as much as possible, and the head turned somewhat to the opposite side. The situation of the external jugular vein should then be ascertained if possible before commencing the incision. It may lie at any point between the posterior border of the sterno-mastoid and the edge of the trapezius; most commonly it is close to the former muscle. Occasionally it is wanting. The operation is commenced by drawing the integuments of the lower part of the neck downwards over the clavicle and making an incision about four inches in length upon the bone, dividing the skin, superficial fascia, platysma, and the supra-clavicular branches of the cervical plexus. When the tension is taken off the part, this incision will be found to traverse the base of the posterior triangle of the neck. The chief object of drawing the skin downwards in this way is to avoid any risk of wounding the external jugular vein, for as this vessel perforates the deep cervical fascia about one finger's breadth above the clavicle, it cannot be drawn downwards with the integuments. In some rare cases the cephalic vein crosses the clavicle and joins the external jugular. It would then necessarily be divided in the first incision. The next step in the operation is to find the external jugular vein. In order to do this the deep cervical fascia must be carefully dissected through close to the clavicle; immediately beneath the fascia a quantity of loose areolar tissue is exposed, in which the lower end of the external jugular will commonly be found. As soon as the deep cervical fascia is divided great caution must be used, the areolar tissue being picked up in small pieces with the forceps and scratched through with the point of the scalpel or torn with a blunt probe or steel director. When the external jugular vein comes into view it must be treated according to its position; if at either end of the wound, it may be drawn aside with a blunt hook; if in the middle, a double ligature must be passed and the vein tied in two places and divided between them. Occasionally the transverse cervical and supra-scapular veins form a plexus with the external jugular immediately above the clavicle, and the difficulty of exposing the artery is then greatly increased. The transverse cervical artery lies normally above the wound, and the supra-scapular is concealed behind the clavicle, but in exceptional cases they may be found in the space exposed in the operation. They must then be drawn out of the way with blunt hooks. By combined cutting and scratching through the areolar tissue, the external

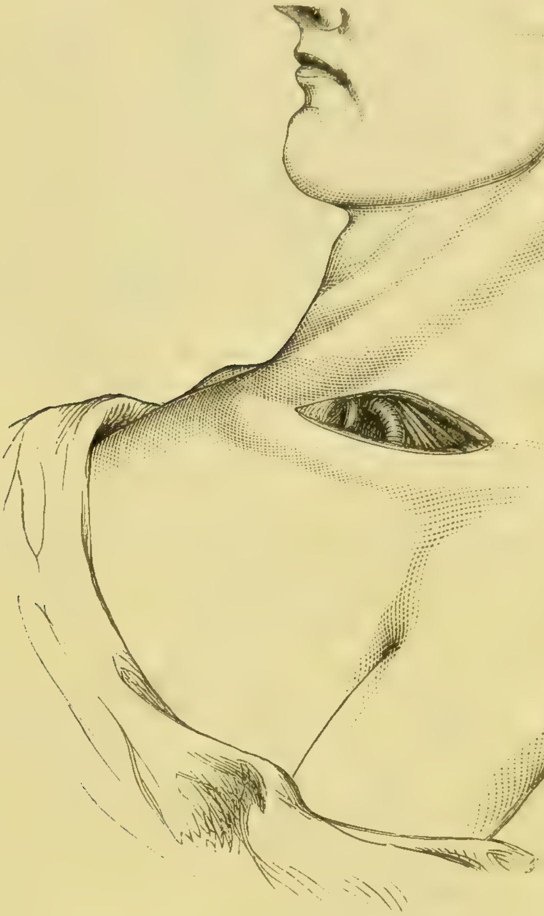


Fig. 482.—Ligature of the Subclavian in the Third Part of its Course.

edge of the scalenus anticus is reached; this is the "directing line" down which the finger is run until the tubercle of the first rib is felt. This is the guide to the artery, which will be found immediately above and a little behind it, covered, however, and bound down by a dense fascia. Immediately above the artery, and in close contact with it, is the lowest cord of the brachial plexus, that formed by the last cervical and first dorsal nerves; beneath the artery is the first rib, upon which it can be felt rolling under the finger when firm pressure is made. At the same time pulsation will be felt, but this must not be taken as proof that the structure beneath the finger is the vessel, for the lowest cord of the brachial plexus lies so close to the subclavian artery that it receives a communicated impulse from it. On firm pressure the nerve still retains its round form, while the artery flattens out, and its surface becomes slightly concave. The thick fascia covering the artery having been carefully opened with the edge of the knife, the needle is passed from the nerve, as low down as possible, so as to avoid any risk of injuring the pleura by slipping over the upper border of the first rib. The subclavian vein is so far below the clavicle that there is no possibility of wounding it. In a considerable proportion of cases the posterior scapular artery will be found springing from the main trunk in this part of its course. In 296 arteries examined by Quain, it arose from the third part as a separate branch in 101, or as nearly as possible one in three cases. If this condition is met with, the ligature must be applied as far as possible to the proximal side of the branch. If necessity requires the ligature to be applied close to the branch, it is perhaps safer to tie this also, as the anastomosis of the vessels in this region is so abundant that the risk of gangrene from the obliteration of a single branch would be very small.

The operation just described is that commonly adopted. In order that it should be easily carried out, it is in the first place necessary that the shoulder should be depressed as far as possible, so as to bring the clavicle down. This is a matter of much importance; for, if the clavicle be thrust upwards by the pressure of a large aneurism, or if it lie high in consequence of emphysema of the lungs, the Surgeon will have to find the artery at the bottom of a deep wound, instead of on a comparatively plane surface. If, therefore, the clavicle cannot be thoroughly depressed, more room must be provided in the superficial parts of the wound. This is done by making a vertical incision upwards either along the border of the sterno-mastoid or from the middle of the wound for about two inches. As the artery is in these cases approached

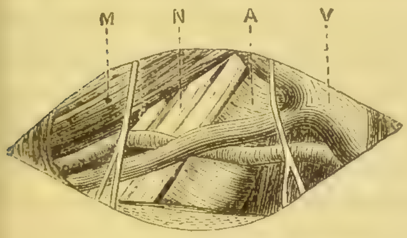


Fig. 483.—Diagram of Right Subclavian Artery in Third Part of its Course, crossed by transversalis colli artery and vein. A. Subclavian artery. V. External jugular receiving transversalis colli veins. N. Brachial plexus of nerves. M. Omo-hyoid muscle.

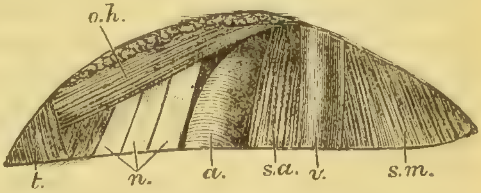


Fig. 484.—Diagram of the Relations of the Third part of the Subclavian Artery: *t.* trapezius; *o. h.* omo-hyoid; *s. a.* scalenus anticus; *s. m.* sterno-mastoid; *v.* external jugular vein; *n.* brachial plexus; *a.* artery.

rather from above than from the front, the structures met with differ somewhat from those already described. The posterior belly of the omo-hyoid is always exposed, and forms an important rallying point in the operation, and the transverse cervical artery and vein will most commonly come into view. The danger of including the lowest cord of the brachial plexus is greater the more the artery is approached from above. The vertical incision should always be made in fat subjects.

In some cases the clavicle may lie so high that the artery cannot be exposed even with the help of the vertical incision. A case occurred to Sir A. Cooper, in which the attempt to ligature the subclavian artery for a large aneurism of the axilla had to be abandoned, in consequence of the clavicle being thrust up to too great a height to allow him to reach the vessel. The extent of the difficulty occasioned by this elevation of the clavicle must necessarily depend in a great measure upon the height at which the subclavian artery happens in any particular case to be situated in the neck. It is not uncommon to find it pulsating so high in the neck that no amount of elevation of the clavicle by a subjacent axillary aneurism could raise that bone above the level of the vessel. In the majority of cases, however, (in seventeen out of twenty-five, as shown by Quain in his work on the *Arteries*,) it is either below the level of the bone, or but slightly raised above it; so that, if the clavicle were thrust upwards and forwards, the vessel would be buried in a deep pit behind it. Dupuytren was of opinion that the artery coursed high in persons who were thin, with slender long necks; whereas, in thick, short-necked persons, with muscular shoulders, it was deeply seated. I have often verified the truth of this observation, both in dissection and in examining the pulsations of the vessel during life.

In order to obviate the difficulty that has occasionally been experienced in reaching the artery when thus buried behind an elevated clavicle, it has been proposed by Hargrave to saw through the bone. The most serious objection that can be raised against this practice, is the fact of the clavicle being sometimes a part of the wall of the aneurism: but, supposing the Surgeon could satisfy himself that this was not the case, I cannot see any objection to this procedure, provided any very great and insurmountable difficulty presented itself in passing the ligature round the vessel without it.

The artery occasionally takes a remarkably high course in the neck, and in some of these instances instead of passing over the first dorsal rib, it is supported on a supernumerary cervical rib, the anatomical relations being thus seriously disturbed. And again, if this supernumerary cervical rib be unusually short, the vessel may be found to lie between it and the first dorsal. Another abnormality of great rarity is the passage of the subclavian vein behind the scalenus anticus with the artery. This would add greatly to the difficulty of the operation.

Accidents during Ligature of the Third Part of the Subclavian.—*Wound of the External Jugular Vein* is a most serious complication, as entrance of air is very likely to take place, and may cause immediate death. This accident is avoided by careful dissection, and if the vein is so situated as to be exposed to the risk of injury, it must be divided between a couple of ligatures.

Profuse venous hæmorrhage from wound of some of the numerous veins in the neighbourhood has more than once prevented the completion of the operation. Should this accident happen the wound must be plugged and the operation attempted again at some later period.

Wound of the Sac is a somewhat rare accident. In some cases, as has already been stated, the sac passes upwards below the clavicle into the inferior posterior triangle of the neck ; when this is the case, the Surgeon incurs the risk of puncturing it from its close proximity to the artery, as it lies on the first rib. This accident happened to Cusack while ligaturing the subclavian in the third part of its course, for a diffused aneurism of the axillary artery. An alarming gush of blood took place, which was arrested by plugging the wound ; but the hæmorrhage recurred on the tenth day, and the patient died. In a case related by Travers, in which the sac was punctured as the needle was being passed round the artery, the blood did not flow *per saltum*, but in a continuous stream. "The hæmorrhage," Travers says, "was more terrific and uncontrollable than I have ever witnessed," and was not commanded by drawing the ligature tight. It was so great that it was doubtful whether the patient would leave the theatre alive, and it was only arrested by plugging the wound with sponge-tents. The patient died of inflammation of the pleura. On examination, the aneurismal sac was found to have a pouch-like enlargement upwards, overlying the artery, where it had been punctured.

Inclusion of the lowest cord of the brachial plexus in the noose of the ligature is a more common accident ; indeed the mistake has more than once been committed of tying these nervous trunks instead of the vessel. Thus, Liston, in the first successful case of ligature of the subclavian in this country, passed the thread round the lower cord ; but immediately perceiving his error, turned it to account by drawing aside the included nerve, and thus more readily exposing the artery. Dupuytren, in a case of aneurism of some years' duration, succeeded, after an operation that lasted one hour and forty-eight minutes, and which he describes as the most tedious and difficult he ever attempted, in passing a ligature round the vessel, as he believed. After the death of the patient, which occurred from hæmorrhage on the ninth day, the artery was found to have been perforated by the needle, and one half the vessel and the lower cord of the brachial plexus included in the noose. In a case related by Porter, it is stated that the artery communicated such distinct pulsation to the inferior nervous trunk, that there was no means of ascertaining whether it was the vessel or not, except by passing the needle under it.

Puncture of the pleura in passing the needle is not usually recognized as one of the dangers of ligature of the third part of the artery. It may, however, take place, especially if the needle is passed close to the scalenus anticus and from above, as must often be the case when the clavicle is much raised.

Ligature behind the Scalenus anticus.—If the sac encroach upon the neck, rising above the clavicle, or the artery be not sound in the third part of its course, it may be necessary to ligature it behind the scalenus anticus, dividing the outer half or two-thirds of the muscle. This operation should not be considered as distinct from ligature of the vessel in the third part of its course, but rather as an extension of that proceeding, if it be found, for the reasons just mentioned, unadvisable to tie the artery on the first rib ; in this way it has been practised by Dupuytren and Liston. In its first steps, as far as the exposure of the scalenus anticus, it is the same as that for the deligation of the vessel in the third part of its course. When this muscle has been exposed, a director must be pushed under it, upon which it is to be divided to the extent of half or two-thirds its breadth, when it retracts, exposing the vessel. During this part of the operation, some danger may be incurred by the phrenic nerve, and the transversales colli and humeri arteries ; but if ordinary care be taken, this will not be very great. The phrenic nerve lies altogether to the tracheal side of the incision, if that be not carried beyond one-half the breadth of the muscle ; and should it appear to be in the way, it may readily be pushed inwards towards the mesial line, being only loosely invested by areolar tissue. I have, however, seen one instance in which the right subclavian artery was ligatured for a spontaneous cylindriform aneurism of the axilla, and the patient died on the eighth day, of pneumonia ; on examination after death, the edge of the scalenus was found cut, and the phrenic nerve divided. Had the injury to the nerve in this case anything to do with the pneumonia ? I do not think it improbable ; as division of one phrenic nerve, by paralysing to a certain extent the diaphragm, and so far interfering with the respiratory movements, must necessarily have a tendency to induce congestion of the lung, which would predispose to inflammation of that organ. I have likewise heard of one case in which incessant hiccough followed this operation, and after death the phrenic nerve was found reddened and inflamed, having probably in some way been interfered with during the exposure of the vessel. The transversales colli and humeri arteries may be avoided by keeping the incision in the muscle between and parallel to these vessels.

Another important point in reference to the ligature of the vessel in this part of its course is, that in five cases out of six on the right side and in one-half on the left, the superior intercostal arises from the subclavian artery between the scaleni. When this is the case, there would probably be but a slender chance of the occlusion of the artery by ligature in this situation.

One principal danger in ligaturing the subclavian artery at any point above the first rib, certainly arises from interference with the fascia which lies between it and the scaleni, separating it from the pleura. This fascia is continuous with the areolar tissue of the anterior mediastinum, being indeed the deep portion of the ascending layer of what Sir A. Cooper has described as the "thoracic fascia," which helps to form the superior boundary of the chest, being continuous in the neck with the deep cervical fascia. After the deeper layers of the cervical fascia have been opened, this fine areolar tissue presents itself ; and, if septic inflammation be excited in it, the morbid process will readily extend by continuity of tissue into the thorax by the anterior mediastinum, invading ultimately the pleura and pericardium. Hence, whenever it is practicable, the Surgeon should keep the point of the needle close to that part of the artery which lies upon the first rib, as there is less risk here of opening into the deep areolar tissue of the neck.

Results of Ligature of the Subclavian.—The general results of ligature of the subclavian in the third part of its course for spontaneous aneurism in the axillary are by no means satisfactory. Thus of 48 cases of aneurism of the axillary artery, not dependent upon any external wound, in which the artery was ligatured above the clavicle, I found 23 cures against 25 deaths. This result was so unfavourable, and so different, indeed, from what I anticipated, that I was led to analyse carefully the causes of death. I found them as follows :—

Inflammation within the chest, &c.	10	cases.
Suppuration of the sac	6	,,
Suppurative phlebitis	1	,,
Hæmorrhage	3	,,
Gangrene of hand and arm	1	,,
Gangrene of both arms and legs	1	,,
Not stated	3	,,
	25	,,

Thus it will be seen that the two most frequent causes of a fatal result following the operation for axillary aneurism, are not those that are usually met with after the ligature of the larger vessels. It would therefore appear to be owing to some special condition, dependent either upon the application of a ligature to the subclavian artery in the third part of its course, or upon the situation and nature of the disease for which that operation is had recourse to; and the important point to be determined is, whether these conditions are the accidental or the necessary consequences of the application of a ligature in this situation for the cure of aneurism in the axilla.

Inflammation of the Contents of the Thorax proved fatal in 10 out of 48 cases, or 1 in 4·8, and is the most frequent cause of death, though not, I believe, the most frequent untoward complication of this operation. It might at first be supposed that the pulmonary complications were due to pyæmia, but, on closer examination, it will be found that this is not the case. Inflammation, when attacking the thorax or its contents after ligature of this artery for axillary aneurism, does not commence in the substance of the lung as in pyæmia, but most commonly affects primarily the pleura and pericardium. It would, therefore, appear probable that it arose from causes that are essentially connected either with this operation or with the aneurism itself. These are referrible to three heads.

1. Septic inflammation of the deep areolar tissue at the root of the neck may extend to the anterior mediastinum, the pleura, and pericardium. This would appear to have been the cause of death in a patient in whom Key tied the subclavian, and has been especially adverted to by that excellent Surgeon in his relation of the case.

2. The sac may, by its pressure inwards, encroach upon and give rise to inflammation of that portion of the pleura which corresponds to its inner aspect. This occurred in a case in which Mayo of Winchester operated, and is more liable to happen if suppuration have taken place in the sac; when this occurs, adhesion may take place between it and the pleura, or even the tissue of the adjacent lung; and the contents of the suppurating tumour may be discharged into the pleural cavity or air-tubes, and so coughed up. Of this there are at least two cases on record; one by Bullen, in which the patient recovered; the other by Gross, in which the patient died from the escape of the contents of the sac into the cavity of the pleura.

3. Division of the phrenic nerve would necessarily, by interfering with the respiratory movements, induce a tendency to congestion and inflammation of the lungs; and, although such an accident must be a very rare one in cases of ligature of the subclavian for axillary aneurism, yet it undoubtedly has occurred, as I have myself witnessed in one case.

Suppuration of the Sac is the most common, though not the most fatal, accident after ligature of the subclavian for spontaneous axillary aneurism. It was the immediate cause of death in six cases, and occurred in two of the patients that died of inflammation of the chest ; it took place in six cases also that recovered : in all, fourteen cases out of forty-five, or nearly one in three, —a much higher proportion than is generally observed in cases of ligature for aneurism.

What occasions this greater frequency of suppuration of the sac in axillary aneurisms than in those in other situations ? One important cause appears to be the great laxity of the areolar tissue in the axilla, which allows the tumour, in almost all cases, to increase so rapidly in size as to excite subacute inflammation in the surrounding structures. This may readily become acute and reach the stage of suppuration owing to external violence, to rapid extension of the sac, or to some constitutional affection on the part of the patient. Thus suppuration of the sac is not an uncommon complication of axillary aneurism even when no operation has been performed on the artery. When a ligature is applied to the subclavian it is in most cases in close proximity to the sac as the aneurism is commonly seated high in the axilla, and as the loose areolar tissue opened up during the operation in the root of the neck is continuous with that of the axilla, it is evident that should septic suppuration occur in the wound it will readily extend to the already inflamed tissues surrounding the sac. In some cases possibly the sac itself may be damaged during the operation. The statistics collected by Koch show a much greater mortality in those cases in which the subclavian artery has been tied for spontaneous aneurisms extending above the upper border of the pectoralis minor, than in those below that point. Of 17 of the former 13 were fatal ; of 22 of the latter only 10 died.

The period at which suppuration of the sac may be expected to occur in cases of axillary aneurism, after the ligature of the subclavian, must necessarily in a great measure be dependent on the state of the sac at the time of the operation. If inflammation have been already set up around it, it may happen a few days after the artery has been tied. But if this morbid process have not already commenced, the period at which suppuration may most probably be expected is between the first and second month. The period at which suppuration and rupture of the sac take place does not influence the probable termination of the case to any material extent ; as, in the cases that prove fatal, death occurred at various periods between the seventh day and the second month ; in Aston Key's case, on the ninth day ; in Mayo's on the twelfth ; in Belardini's and Gräfe's, at the end of the first month ; in Rigaud's at the sixth week ; in B. Cooper's, in the second month. The recoveries, likewise, took place at all periods after the ligature of the vessel, between a few days, as in Porter's, and six weeks, as in Halton's case.

An axillary aneurism that has suppurated may burst either externally, or into the lungs or pleura, or both. It is most usual for it to burst externally ; the tumour enlarges, with much pain and tension ; a part of the skin covering it becomes inflamed ; fluctuation can be here felt, and, if an incision be not made, the tumour will give way, discharging most usually a quantity of dark-coloured pus, mixed with more or less broken-down and disintegrated coagulum, and perhaps sooner or later followed by a stream of arterial blood.

Occasionally, but more rarely, the sac, extending inwards, perforates the cavity of the chest and becomes adherent to the pleura, and may give way into its cavity ; or, by pressing upon the lungs, may become incorporated with them. Of this remarkable termination two instances are recorded, in one of which recovery took place. The first case is one in which Bullen ligatured the subclavian artery for axillary aneurism. Eighteen days after the operation the tumour began to increase, and to take on the symptoms that are indicative of suppuration. On the twenty-sixth day six or eight ounces of bloody pus were expectorated during a paroxysm of coughing, and the tumour suddenly diminished to one half its size ; it was now punctured, and five ounces of the same kind of matter were let out with great relief. When the patient coughed, air passed into and distended the sac through an aperture between the first and second ribs, near their sternal extremities, through which the contents of the tumour had escaped into the lung. The discharge from the external aperture greatly decreased ; the cough lessened ; and finally, three months after the operation, the patient was quite well.

Gross tied the subclavian artery for axillary aneurism on the 18th of February. After the performance of the operation the contents of the tumour solidified, and its volume progressively diminished. On the 15th of March, the patient suffered from fever, and slight tenderness on the apex of the tumour was perceptible. On the 16th he was suddenly seized with intense pain in the chest, which was particularly severe at the base of the right lung, and extended up towards the axilla. Respiration throughout the right lung was bronchial, and there was dulness on percussion over the lower ribs ; the aneurismal tumour had suddenly disappeared at the time of the attack. On the 18th, the patient experienced a sensation as if a fluid were passing from the pleural cavity into that of the aneurismal tumour ; and, upon auscultating, a splashing sound was heard at every inspiration, the noise resembling that produced by shaking water in a closed vessel. On the 20th, he died. Upon dissection, the aneurism was found to communicate by an aperture, one inch and three-quarters in length and an inch and a half in width, with the pleural cavity ; this opening was situated between the first and second ribs, and was obviously the result of ulceration and absorption, caused by the pressure of the tumour. Both ribs were denuded of their periosteum. The right side of the chest contained nearly three quarts of bloody serum, intermixed with laminated clots and flakes of lymph.

Besides these cases, a somewhat similar one has been recorded by Neret, of Nancy. A patient was admitted into the hospital, suffering from hæmoptysis, and on examination was found to have an aneurism of the left subclavian artery as large as a chestnut. He died shortly after admission ; and, on examination, the aneurism was found to communicate with a large cavity in the upper part of the lung.

The cause of death in Gross's case was probably the fact of the sac opening and discharging its contents into the pleural cavity. This does not appear to have occurred in Bullen's, in which a communication was established directly with the lung, the contents of the abscess finding exit through the air-tubes. The process here was analogous to what occasionally occurs in hepatic abscess when this opens through the lungs, adhesion having previously taken place between the opposed surfaces of the pleura.

In Furner's case of axillary aneurism, both arteries became affected by the disease, and both subclavians were tied in the third part of their course at an interval of about fifteen months. In this most remarkable and interesting case, the result of which reflects much credit on the skill and decision of the operator, the patient, a stone-mason by trade, made an excellent recovery from the first operation. After the second operation he progressed most favourably for twelve weeks, by which time the tumour had diminished so much as to be not more than a third of its original size. Without obvious reason febrile disturbance set in, the tumour enlarged again, and showed signs of suppurating. Furner now made a free incision into it through the pectoral muscle, and let out 18 or 20 ounces of very offensive pus and broken-down coagulum. The patient speedily recovered, the tumour disappearing entirely.

The principal danger, and the most frequent cause of death after the suppuration of the sac, is the supervention of profuse arterial hæmorrhage. This may occur either from the distal extremity of the artery opening into the sac, or from one of the large branches which serve to support the collateral circulation round the shoulder, such as the subscapular or posterior circumflex, coming off either immediately above or below the sac, or from the sac itself. When hæmorrhage does not take place after suppuration of the sac, it must be from the fortunate circumstance of the occlusion of the main trunk, where it opens into the tumour. It can scarcely be from the occlusion of the principal collateral branches, as there would, in this event, be a difficulty in the preservation of the vitality of the limb. It is easy to understand that, if the sac sprang from the axillary, at a little distance above the orifices of the subscapular and circumflex arteries, all that portion of the main trunk which intervenes between the tumour and these vessels might be occluded, and thus hæmorrhage be prevented on suppuration taking place; whilst the collateral circulation would take place uninterruptedly through these vessels. If this portion of the artery have not been occluded by inflammation, the safety of the patient must depend upon the accident of a coagulum or piece of laminated fibrin being fixed or entangled in the mouth of the sac. This may prevent for a time the escape of arterial blood, which, on such a plug being loosened, may break forth with impetuosity, and either at once, or by its recurrence at intervals, carry off the patient.

Another danger may be superadded in these cases to the suppuration of the sac and the supervention of hæmorrhage—namely, the occurrence of inflammation of the pleura, lung, and pericardium, from extension inwards of the morbid process going on in the sac.

Secondary hæmorrhage does not frequently occur in cases of ligature of the subclavian artery in the third part of its course, except as a consequence of suppuration of the sac. I myself have seen but two cases in which death occurred from hæmorrhage taking place from this artery at the part ligatured. One of these happened to Liston, and the preparation is preserved in the Museum of the College of Surgeons (No. 1695). In this case it may be seen that the artery was diseased at the point ligatured, and that the bleeding occurred, as usual, from the distal side of the ligature. Barwell, taking Koch's table of 79 cases, and adding to it 11 collected by himself, finds that of 32 deaths occurring in the 90 cases, 10 were from hæmorrhage from the site of ligature.

Gangrene of the Hand and Arm is but seldom met with as a sequela of the operation we are considering. This is doubtless owing to the freedom of the anastomosing circulation between the branches of the transversalis colli and suprascapular, and those of the subscapular, circumflex, and acromio-thoracic arteries, as well as between the superior and long thoracic and the branches of the intercostals and internal mammary, by which the vitality of the limb is readily maintained. The principal risk from gangrene would doubtless arise from the subscapular artery being in any way occluded or implicated in the disease, as it is on the anastomoses of this vessel that the limb is mainly dependent for its supply of blood. But, at all events, this danger is small, the only case in which it appears to have given rise to a fatal termination being one in which Colles tied the artery; gangrene of the limb came on after much constitutional disturbance, with rapid, weak pulse, thirsts, sweats, restlessness, and delirium. In Blizzard's case, there were sloughing of the sac, and pericarditis, the gangrene being confined to two fingers : and in Brodie's case, it occurred in both the lower as well as in the upper extremities, and must, therefore, have proceeded from some constitutional cause altogether independent of the mere arrest of circulation through the subclavian.

Failure of the operation to cure the disease if the above accidents are avoided is a very rare occurrence. A case of this kind occurred to Berkeley Hill in University College Hospital. The subclavian was successfully tied for a large axillary aneurism ; there was some inflammation about the sac after the operation, which gradually subsided. Some months afterwards the tumour began steadily to increase in size without pulsation, and finally the sac was laid open and the vessel tied from within, and the patient made a good recovery.

On reviewing the causes of death, it may be reasonably hoped that the average of success will be materially increased by the use of ligatures which do not divide the coats, and by the prevention of septic and spreading inflammation in the wound by the employment of antiseptic dressings.

Treatment of Inflamed Axillary Aneurism threatening Suppuration.—The case of an axillary aneurism becoming inflamed, and threatening to suppurate *before* the Surgeon has had an opportunity of ligaturing the subclavian artery, is one that is full of important practical considerations, and that admits of little delay ; for if the sac rupture, or be opened, fatal hæmorrhage is the inevitable result. It would obviously be impossible, in a case of spontaneous aneurism, with any fair chance of success to lay open the tumour, turn out the coagula, and ligature the vessel above and below the mouth of the sac ; the coats of the artery, being not only diseased, but still further softened by inflammation and supervening suppuration, would not be in a condition to hold a ligature. There are two other courses open—viz., ligature of the subclavian, or amputation at the shoulder-joint ; and in the selection of one or other of these, the Surgeon must be guided by the progress the disease has made, the condition of the limb as to circulation and temperature, and the solidity or fluidity of the contents of the tumour.

If the tumour be of moderate size and circumscribed, and the arm of a good temperature and not very œdematous, *ligature of the artery* may hold out a reasonable chance of success. It is true that this is but a chance : for the blood will, immediately after the noose is tied, be carried by the suprascapular and posterior scapular arteries into the subscapular and circumflex, and by them into the axillary at no great distance from the mouth of the sac ; or it may enter directly into the mouth of the latter, if the subscapular or circumflex should chance to take their origin from the dilated portion of the vessel. Hence, the only safeguard against the supervention of hæmorrhage as soon as the sac has burst or been opened, or has discharged its contents, will be the occlusion by thrombosis of that portion of the artery which intervenes between these two collateral branches and its mouth, or the accidental entanglement in the latter of a mass of laminated fibrin. Yet, in the circumstances as to the condition of tumour and limb that have just been mentioned, it would be but right for the Surgeon to give the patient a chance of preserving his arm.

Should, however, hæmorrhage occur on or after the discharge of the contents of the sac, the subclavian having previously been ligatured, if the bleeding be moderate, an attempt should be made to arrest it by plugging the wound, and by the application of a compress and bandage. If it recur, or be so profuse as to threaten the life of the patient, two lines of procedure are open to the Surgeon: either to cut through the pectoral muscles so as to lay the sac open fully, and attempt to include the bleeding orifice between two ligatures; or to amputate at the shoulder-joint.

If a Surgeon were to undertake the first of these alternatives in a case of spontaneous aneurism, of which alone we are now speaking, he would, in all probability, find the part in such a condition as would prevent the possibility of his completing the operation he had commenced. After laying open a large sloughing cavity, extending under the pectoral muscles perhaps as high as the clavicle, and clearing out the broken-down coagula contained in it, in what state would he find the artery? Certainly, the probability would be strongly against its being in such a condition as to bear a ligature, even if it could be included in one. Its coats, in the immediate vicinity of the sac, could not, in accordance with what we know to be almost universally the case in spontaneous aneurisms of large size or old standing, be expected to be in anything like a sound firm state, and would almost certainly give way under pressure of the noose; or the vessel might have undergone fusiform dilatation, as is common in this situation, before giving rise to the circumscribed false aneurism, in which case it would be impossible to surround it by a ligature, or, again, the subscapular or circumflex arteries might arise directly from, and pour their recurrent blood into, the sac or the dilated artery, and, as they would lie in the midst of inflamed and sloughing tissues, no attempt at including them in a ligature could be successfully made. In such circumstances as these, the danger of the patient would be considerably increased by the irritation that would be occasioned by laying open and searching for the bleeding vessel in the sac of an inflamed, suppurating, and sloughing aneurism, and much valuable time would be lost in what must be a fruitless operation; at the close of which it would, in all probability, become necessary to have recourse to disarticulation at the shoulder-joint, and thus to remove the whole disease at once. I should, therefore, be disposed to have recourse to *disarticulation at the shoulder-joint* at once, in all cases of profuse recurrent hæmorrhage, following sloughing of the sac of an axillary aneurism, which could not be arrested by direct pressure on the bleeding orifice, after the subclavian has been tied.

There is another complication of axillary aneurism that necessitates immediate amputation at the shoulder-joint, whether the subclavian artery have previously been ligatured or not; it is the case of diffuse aneurism of the armpit, with threatened or actual gangrene of the limb.

Ligature of the Axillary Artery.—Should ligature of the axillary artery at any time be required, the vessel may be secured in one of two situations, in the space that intervenes between the lower margin of the clavicle above the pectoralis minor, or in the axilla as it lies on the tendon of the latissimus dorsi.

To expose the artery above the pectoralis minor, the shoulder must be pushed upwards and allowed to fall backwards as far as possible. An incision is then made, slightly curved with its concavity upwards, commencing immediately above and internal to the tip of the coracoid process, and terminating immediately below the clavicle, and about one inch from the sterno-clavicular articulation. The skin and fat are divided in the first incision, and the pectoralis major exposed. The fibres of the muscles are separated in the inner end of the wound, and the finger introduced into the space beneath guiding a probe-pointed bistoury, with which the remainder of the muscle is rapidly divided throughout the whole length of the wound. In doing this, several large branches of the acromio-thoracic artery are divided and must be tied at once. The next rallying point is the upper border of the pectoralis minor. This must be found by tearing through some loose areolar tissue with the forceps and a steel director, so as not to wound the branches of the acromio-thoracic artery and vein. The cephalic vein lies at the outer angle of the wound, and is usually not seen. When the pectoralis minor is found, it must be drawn downwards with a copper spatula. In so doing, the costo-coracoid membrane beneath which the artery lies is brought fully into view. This membrane is seldom sufficiently distinct to be recognized as a definite structure, and it can readily be torn through with a pair of forceps and the steel director. It is perforated by the acromio-thoracic artery and vein, and the external anterior thoracic nerve. These will be seen as the areolar tissue is torn through, and must be drawn inwards with a blunt hook. In the living body the vein next comes into view, and must be drawn inwards, when the artery will be seen to its outer side. The needle must be passed from the vein and as near the clavicle as possible, well above the origin of the acromio-thoracic. If it is possible to tie only in close proximity to this branch, it would be safer to apply a ligature to it also. In practising the operation on the dead body, the vein often is not seen, and it is customary to find the artery by following the acromio-thoracic to its origin. There is little risk of

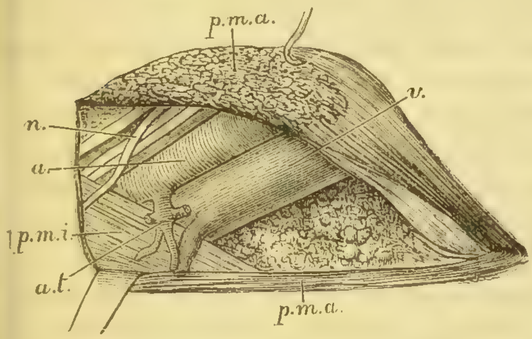


Fig. 485.—Diagram of Ligature of the First Part of the Right Axillary Artery. *p.m.a.* Pectoralis major, the fibres separated in the inner half of the wound and divided in the outer; *p.m.i.* pectoralis minor; *a.t.* Acromio-thoracic artery and vein; *a.v.* axillary vein; *a.* axillary artery; *n.* brachial plexus.

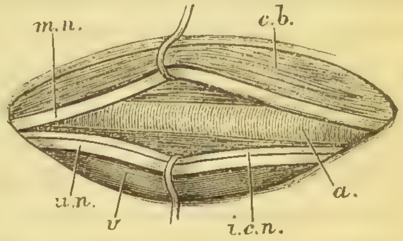


Fig. 486.—Diagram of Ligature of the Axillary Artery in its lower third. *c.b.* coraco-brachialis; *m.n.* median nerve; *u.n.* ulnar nerve; *i.c.n.* internal cutaneous nerve; *v.* vein; *a.* artery.

including a cord of the brachial plexus, as the nerves lie well to the coracoid side, separated by a slight interval from the artery. It is frequently found in the dead body that the ligature has been applied above the lower border of the first rib, the end of the subclavian being actually the vessel tied. This operation is a very difficult one, on account of the depth of the wound as well as from the embarrassment occasioned by the numerous venous and arterial branches which ramify across the space in which the vessel lies, and ligature of the third part of the subclavian is to be preferred to it whenever it is practicable.

If it is necessary to tie the axillary, as in the case of a punctured wound, the operation recommended by Guthrie is probably safer and simpler than that just described. It consists in making an incision from the centre of the clavicle directly downwards, in the course of the vessels, to the middle of the anterior fold of the axilla. In this way the skin, superficial fascia, and greater pectoral muscle, must be successively divided. The lesser pectoral will then be exposed; and the artery may be ligatured above or below this, without further division of muscular substance, or if it be thought desirable to tie it under this, the muscle must be cautiously cut through. When this is done, a very distinct and firm fascia will come into view ; this must be picked up and be carefully opened, when the artery and vein will be seen lying parallel to one another, the artery being to the outer side. The vein having been drawn inwards, the aneurism-needle must be carried between it and the artery. The second part of the artery has the three cords of the brachial plexus in close contact with it, the inner lying between it and the vein. At the lower border of the pectoralis minor the inner head of the median crosses the artery. Care must be taken not to include these nerves in the ligature. The great advantage of this operation is, that the wound is open and free, and that, consequently, the artery can be more readily reached in any part of its course. The disadvantage is the great division of muscular substance that it entails. This, however, need not leave any permanent weakness of the limb, as by proper position union may be readily effected between the parts.

The axillary artery may also be ligatured at any point below the lower border of the pectoralis minor, by making an incision parallel to its course in the axilla. The guiding line for the vessel in this situation is obtained by dividing the space between the anterior and posterior folds of the axilla into three equal parts, when the artery will be found to lie at the junction of the anterior with the middle third. The arm being held at an obtuse angle with the trunk, so as to make the skin tense, an incision is made, commencing at the thoracic border of the axilla and extending for a distance of about three inches parallel to the course of the artery. The incision must be made so as to divide the skin only. The fascia, being exposed, must be carefully opened, when the axillary vein will come into view, and must be drawn to one side with a blunt hook. The artery will now be seen surrounded by the nerves of the brachial plexus. In front of it or to its inner side is the internal cutaneous. To its inner side between it and the vein is the ulnar ; the nerve of Wrisberg is still further internal, usually beyond the vein. To the outer side is the median, and for a short distance above, the external cutaneous lies on the same side of the vessel before entering the coraco-brachialis. Behind is the musculo-spiral. and as far as the upper border of the teres major, the circumflex. The nerves are easily held aside, and the ligature is passed round the artery from the vein.

If the ligature be applied near the termination of the axillary artery, as it lies over the tendons of the latissimus dorsi and teres major, it will not be in immediate contiguity to any large branch. Above this point, it must be applied close to either the subscapular or the circumflex arteries, which would perhaps somewhat add to the danger of secondary hæmorrhage. In a fat axilla there is some risk of missing the artery by drifting too much towards the posterior border of the space. To avoid this, and also to get rid of the inconvenience caused by the situation of the vein covering the artery, Malgaigne recommended that the incision should be made a little nearer the anterior border of the axilla, and the edge of the coraco-brachialis sought as the first rallying point. When this is found it is drawn slightly forwards, when the median nerve will be seen in contact with it. If this be drawn on one side, the artery at once comes into view. By this method the artery can often be tied without the vein being seen, and it is impossible to miss the vessels by getting too far to the inner side. Ligature of the axillary is very rarely required for aneurism. It has been done as a distal operation for subclavian aneurism, but without success.

ANEURISM OF THE ARM, FOREARM, AND HAND.

Spontaneous aneurism rarely occurs below the axilla, yet it may occasionally be met with at any part of the upper extremity. Thus G. Buchanan has recorded a case of spontaneous aneurism in the upper third of the brachial artery ; Palletta, Flajani, Pelletan, and others, relate cases of spontaneous aneurism at the bend of the arm ; and Liston states that he once tied the brachial artery in an old ship-carpenter, who, whilst at work, felt as if something had snapped in his arm. Pilcher has recorded a case of aneurism under the ball of the right thumb, which was produced by repeated though slight blows with the handle of a hammer used by the patient (a working goldsmith) in his trade ; the radial and ulnar arteries were tied immediately above the wrist, and the disease was thus cured. Aneurism has also been met with in this situation after attempted reduction of a dislocation of the thumb. In the Museum of the College of Surgeons there is a preparation of a radial artery with a small aneurism, about the third of an inch in diameter, formed by the dilatation of all the coats of a narrow portion of one half the circumference of the vessel, a little above the origin of the superficialis volæ. Spontaneous aneurism in the forearm is of extremely rare occurrence. Todd and Arnott both successfully tied the brachial in its upper third for spontaneous aneurism of the forearm. De Morgan records a case of spontaneous aneurism of the ulnar, and Spanton one of the radial artery. In most of the cases in which the brachial artery and its primary branches have been the seat of spontaneous aneurism, disease of the heart and of the arterial system in other parts has co-existed.

While spontaneous aneurisms are rare in these situations, the traumatic forms of the disease are, as has already been stated (Vol. I., pp. 476, 478), of more frequent occurrence.

Treatment.—In cases of aneurism below the axilla, direct pressure may be tried with advantage, provided the tumour be of small size and unattended by inflammation of the superjacent integuments. Compression of the trunk of the artery above the tumour is rarely applicable, on account of the pain that is induced by the pressure upon the neighbouring nerves, which cannot be isolated from the artery. Besides this, the brachial artery is so mobile, and the humerus so small and round a bone, that the vessel cannot be steadily compressed against it for any length of time, but will roll away from under the pressure, even if the patient could bear the pain of it. The application of Esmarch's bandage under chloroform might be tried in suitable cases.

Ligature of the Brachial Artery.—The brachial artery may be ligatured in the *middle of the arm,* which is considered the seat of election of this operation, by making an incision, about three inches long, parallel to and upon the inner edge of the biceps (Fig. 487), which is the "directing line," and the first rallying point; the fascia, which is exposed, must be opened carefully to a corresponding extent, and the edge of the biceps drawn outwards, when the median nerve will commonly be seen crossing the artery; this must be drawn on one side with a blunt hook, when the artery, accompanied by its two veins, will be exposed; these vessels must then be separated from one another, and the ligature passed and tied in the usual way. In performing this operation, the principal point to attend to is to cut down upon the inner edge of the biceps, which will be the sure guide to the artery (Fig. 488). If the Surgeon keep too far back, he may fall upon the ulnar nerve and the basilic vein, which might possibly be mistaken for the brachial artery; by taking care to expose the fibres of the biceps in his early incision, he will avoid this error. The fascia over the median nerve must be opened thoroughly, otherwise the artery may be drawn on one side with it. The needle must be passed from the nerve.

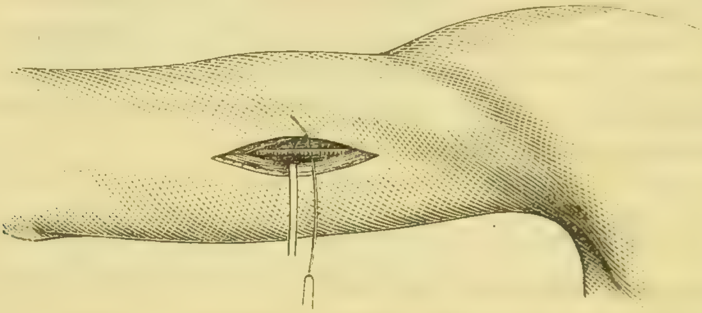


Fig. 487.—Line of Incision for Ligature of the Brachial in the middle of the arm.

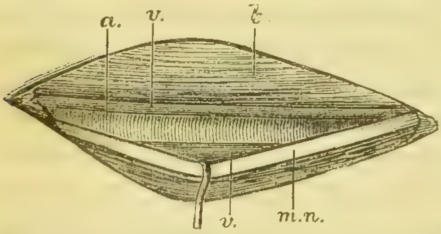


Fig. 488.—Diagram of the parts concerned in Ligature of the Brachial in the middle of the arm. *m.n.* Median nerve drawn inwards; *b.* biceps; *v.v.* Venæ comites; *a.* brachial artery.

In the *upper part of the arm* the operation for ligature of the brachial is practically identical with that for the terminal part of the axillary, the inner edge of the coraco-brachialis being taken as the directing line and the first rallying point.

At the *bend of the elbow* the brachial artery may be reached by making an incision about two inches in length downwards and outwards parallel to and immediately above the median basilic vein when that vessel can be seen;

when it can not, the incision must be at an angle of 45° with the line of the limb, commencing about one inch external to and half an inch above the tip of the inner condyle of the humerus, and terminating at the outer side of the tendon of the biceps. It must not be carried further outwards or the median cephalic vein will be divided. If the median basilic vein is seen, it must be drawn downwards to avoid wounding the ulnar veins which enter it below. As soon as the integumental structures are divided, with the branches of the internal cutaneous nerve, the strong process from the tendon of the biceps to the fascia of the fore-arm, the bicipital fascia, comes into view. This must be carefully divided; the artery will be found beneath, having the biceps tendon to its outer side, the median nerve to its inner side, and a vena comes on each side. The needle must be passed from the nerve. It sometimes happens that the operator misses the artery and comes down upon the brachialis anticus which lies beneath it. This muscle is readily recognized by its surface being composed at this part of alternate strips of tendon and muscular fibres. If circumstances require the operation to be performed a little higher up, the edge of the biceps must be taken as the guide, as in the middle of the forearm.

Ligature of the Radial and Ulnar Arteries.—These arteries may be ligatured at any part of their course, but the operation is never performed above the middle third of the arm except for direct wound.

The **Ulnar Artery above the Wrist** may be readily ligatured by making an incision (Fig. 490) about two inches in length along the outer side of the tendon of the flexor carpi ulnaris, which is the directing line to the vessel. The incision should terminate about half an inch above the pisiform bone. If the edge of the tendon cannot be clearly felt, the incision must be made in the line of the artery. This is found by drawing a straight line from the tip of the inner condyle of the humerus to the radial edge of the pisiform bone. The first rallying point is the edge of the tendon of the flexor ulnaris. As soon as this is clearly exposed it must be drawn inwards with a blunt hook, the wrist being slightly flexed to relax the muscle. A distinct fascia, usually marked by transverse fibres, then comes into view; this must be carefully opened and the artery will be found beneath, accompanied by a vein on each side and the ulnar nerve to the ulnar side (Fig. 489). The needle must be passed from the inner side. The artery lies between the tendons of the flexor carpi ulnaris and of the flexor digitorum sublimis and upon those of the flexor profundus. The mistake most likely to be made is carrying the incision too far inwards so as to miss the tendon; the error is recognized by finding fleshy fibres directed downwards and outwards; the tendon is to the radial side of these.

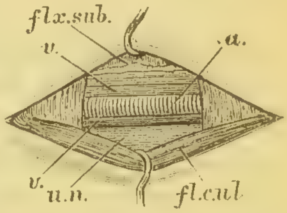


Fig. 489.—Diagram of the Ulnar Artery at the Wrist. *flx.sub.* flexor sublimis digitorum; *fl.c.ul.* flexor carpi ulnaris; *v.v.* veins; *a.* artery.

Ligature of the Ulnar Artery in the Middle of the Arm is a more troublesome operation, as the artery lies deeply on the flexor profundus covered by the superficial muscles of the fore-arm. It can, however, be reached without difficulty by separating the flexor carpi ulnaris from the contiguous border of the flexor digitorum sublimis. To find the interval between these two muscles, a line must be drawn from the tip of the inner condyle of the humerus to the radial edge of the pisiform bone. This line corresponds to the outer edge of the flexor carpi ulnaris and also in its lower two thirds, to the course of the artery. The upper part of the artery passes beneath the superficial muscles of the fore-arm from the middle of the hollow in front of the fore-arm to the junction of the upper and middle thirds of the line just mentioned. The operation is thus performed: the guiding line having been found, an incision two inches in length is made in it (Fig. 490) through the skin and fat. A white line then comes into view formed by a few tendinous fibres in the edge of the flexor ulnaris. If more than one white line is seen a piece of ligature thread may be placed with one end on the inner condyle, and the other on the radial edge of the pisiform bone; the line corresponding to this is the one sought for. The point of the knife is then run lightly along the radial side of the line, after which the flexor sublimis and flexor ulnaris can be easily separated with the handle of the scalpel. The direction of the interspace is towards the ulna. On separating the muscles the artery may appear at once with a vein on each side of it lying on the flexor profundus. More commonly the ulnar nerve is first seen; when this comes into view, the flexor sublimis must be raised and drawn outwards, when the artery will be found coming out from beneath it to join the nerve lower down. The needle must be passed from the inner side. The common error in this operation consists in making the incision too much to the radial side and opening the interval between the flexor sublimis and the palmaris longus by mistake. The error is at once recognized by finding that the interspace leads towards the radius instead of the ulna.

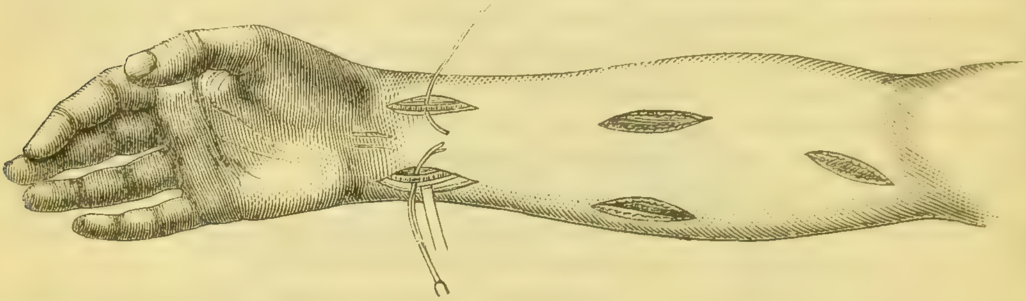


Fig. 490.—Lines of Incision for Ligature of the Brachial Artery at the bend of the elbow and the radial and ulnar arteries in the middle of the fore-arm and at the wrist.

The **Radial Artery above the Wrist** may be ligatured by making an incision about one and a half to two inches in length, a quarter of an inch outside the tendon of the flexor carpi radialis—the "directing line"; when after the division of the superficial and deep fasciæ, the artery accompanied by its two veins will be exposed, and may be tied in the usual way. The artery lies between the tendons of the flexor carpi radialis and supinator longus, and is separated by some fat from the pronator quadratus.

The **Radial Artery in the middle of the Fore-arm** can easily be ligatured by an incision made in a line drawn from the middle of the hollow in front of the elbow to the root of the styloid process. At this part it is overlapped by the belly of the supinator longus, and lies on the insertion of the pronator teres. The incision should be about two inches in length; after the fascia is divided the supinator comes into view, its internal edge must be found and the muscle turned outwards. A distinct fascia is found beneath it, on opening which the artery will be seen with a vein on each side. The radial nerve is about half an inch to the outer side, and is usually not seen.

Ligature of the Radial Artery at the Wrist has sometimes been done for aneurism of the palm, but is more commonly required for wound. The artery at this part of its course lies deeply on the external lateral ligament of the wrist joint. It winds round the lower end of the radius, passing beneath the extensor ossis metacarpi and extensor primi internodii pollicis, and then under the extensor secundi internodii. The operation is performed by making an incision from the base of the metacarpal bone of the thumb to the posterior part of the root of the styloid process of the radius in such a way as to be midway between the tendons of the extensors of the first and second phalanges of the thumb. In the superficial fat will be found the radial vein (which must not be mistaken for the artery) and some branches of the radial nerve. A fascia extending between the two tendons is then found and carefully opened, when the artery will be seen crossing the wound obliquely rather towards its lower end. This operation should never be performed in preference to that in front of the wrist, as it is more difficult and is apt to leave some stiffness in the tendons of the extensors of the thumb.

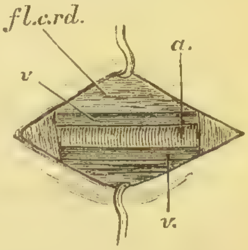


Fig. 491. — Diagram of the Radial Artery. *fl.c.rd.* Flexor carpi radialis ; *v. v.* veins ; *a.* artery.

CHAPTER XLV.

ANEURISMS OF THE ABDOMEN AND LOWER EXTREMITIES.

ANEURISM OF THE ABDOMINAL AORTA AND ITS BRANCHES.

As, until recently, any surgical treatment of these aneurisms was considered impossible, they were left entirely in the hands of the physician ; but since the introduction of compresssion of the aorta under prolonged anæsthesia, by Murray of Newcastle, they have become fairly entitled to a place in a work on Surgery.

Aneurism of the abdominal aorta is a rare affection, and is met with almost exclusively in men. It may occur at any part of its course, but the most common situation is near the origin of the cœliac axis ; and here the disease is often not confined to the main trunk, but one or more of the branches are also affected. The situation next in order of frequency is at or near the bifurcation. Aneurisms may form in connection also with any of the main branches of the abdominal aorta, most frequently on the superior mesenteric, splenic, and inferior mesenteric. The aneurism may be sacculated or tubular. When growing from the main trunk, it is usually of the former variety.

Symptoms.—The chief sign of the disease is the existence of a pulsating tumour, situated in or near the middle line, somewhere between the costal margin and the region of the umbilicus. The pulsation of the tumour is of the expansile kind characteristic of aneurism, and there is frequently a distinct bruit. Walshe mentions a single systolic murmur, a dull muffled systolic sound convertible into a murmur by a little pressure, a sharp, abrupt, short systolic murmur on the left side of the lumbar spine, a systolic murmur audible below the sac, but not over it, and occasionally a dull second sound, as having been heard in various cases of abdominal aneurism. The exact shape and size of the tumour and the nature of its pulsation can in many cases be ascertained only by fully relaxing the abdominal muscles by the use of chloroform. The sensation of pulsation in the epigastrium may be very perceptible to the patient, or may be entirely absent. Constant aching lumbar pain is a very frequent symptom. The pressure-signs are not usually very marked till late in the disease. Pressure on the vena cava to such an extent as to cause œdema of the lower extremities is almost unknown. The sac may press on the lumbar plexus, and give rise to signs of irritation in the course of its branches. The most marked of these are pains in the groin and testicles from irritation of the genito-crural, and occasionally shooting pains down the thigh, in the course of the anterior crural or external cutaneous nerve. When the bodies of the vertebræ are eroded, constant lumbar pain will be frequently present, of the same burning, boring character as that felt in thoracic aneurism under similar circumstances. In some cases the pressure may affect the great intestine, causing considerable difficulty in defæcation. Occasionally the tumour may attain an enormous size before death, half filling the cavity of the abdomen. The fatal termination may be due to gradual exhaustion from pain and interference with the functions of the abdominal viscera, to sudden rupture of the sac into the peritoneum or subperitoneal tissue, or into some part of the alimentary canal, or, more rarely, into the pleural cavity through the diaphragm.

The **Diagnosis** rests chiefly on the situation of the tumour, its distinct expansile pulsation, the existence of an aneurismal bruit, and the pressure-signs. Very *marked epigastric pulsation* is not an unfrequent symptom in anæmic patients suffering from atonic dyspepsia, and in these cases very slight pressure on the artery from a stethoscope will give rise to a distinct bruit. Under these circumstances, it is sometimes not easy to speak positively as to the condition of the artery, but in the majority of cases a careful examination under chloroform will determine the nature of the disease. A *displaced or enlarged heart* also gives rise to distinct epigastric pulsation, but this can hardly be mistaken for aneurism. A *solid mass of fæces* in the transverse colon may receive a very distinct impulse from the aorta, but the doughy feel of the mass, its superficial nature, and the history of the case, will usually readily determine its nature. A *prominent lumbar vertebra* pushing the aorta forward may simulate a dilatation of the artery. *Cancerous lumbar glands* surrounding the artery may give rise to considerable difficulty in diagnosis; and here again a careful examination under chloroform is the most likely means of arriving at a correct conclusion. *Cancerous tumours* growing from the *bones* may give rise to almost insuperable difficulties in the diagnosis. From *tumours of the various abdominal viscera*, the diagnosis must be made on general principles. The amount of fat in the abdominal walls necessarily has a great influence on the difficulty or ease of coming to a definite conclusion.

Treatment.—In all cases of aneurism of the abdominal aorta, constitutional treatment should be given a fair trial before any more severe measures are adopted. Tuffnell has recorded two cases in which a cure was effected by diet and rest—in one case in 21 days, and in the other in 37. If this treatment fail, the Surgeon may have recourse to **compression of the abdominal aorta.** The pain of this application is so severe that, in order to relieve it, the patient must be kept under the influence of chloroform; moreover, without thorough relaxation of the abdominal muscles it is impossible to employ it efficiently. The credit of introducing this mode of treatment is undoubtedly due to Murray of Newcastle-on-Tyne. The operation has now been performed for aortic aneurism in ten recorded cases. In six, under Murray, Durham and Moxon, Durham, Greenhow and Hulke, Pollock, and Sir James Paget, the pressure was applied on the proximal side of the sac. Of these, three—Murray's, Durham and Moxon's, and Greenhow and Hulke's—were successful; one, Pollock's, failed; and two, Durham's second case, and Sir James Paget's, were fatal. In four the pressure was applied on the distal side of the sac: one, under Bryant, and one under Lunn and Benham, terminated fatally, and the other two, under Marshall and Barwell, failed. In most cases the pressure has been applied by the instrument known in this country as Lister's aortic tourniquet. That this instrument may in some cases be safely applied to the abdominal aorta from the highest point at which the artery can be reached to its bifurcation, is clearly proved by the results of the cases above mentioned. In Durham and Moxon's case, it is stated that "by positioning the body of the patient, just sufficient space was afforded for the introduction of the pad of the tourniquet between the cartilages of the ribs and the aneurism." In Greenhow and Hulke's case, it was applied midway between the xiphoid cartilage and the umbilicus, immediately above the tumour. That three out of the eight cases have terminated fatally, however, shows that the operation is by no means devoid of danger. In Pollock's unsuccessful case the patient suffered from hæmaturia, and in Greenhow's case albumen appeared in the urine after the last operation, thus showing serious interference with the circulation in the kidney. In Marshall's case the patient suffered from retention of urine for some days after one operation, probably from some injury to the hypogastric plexus. In Bryant's case the *post mortem* examination showed bruising of the mesentery and intestine and peritonitis, and "the tissues about the compressed aorta were loaded with effused blood." In Lunn and Benham's case death occurred on the eleventh day from gangrene of the jejunum. In Paget's case an abscess had formed in the mesentery, peritonitis had been set up, and the mesenteric artery was found to be compressed and flattened, and embolic clots were found in its branches. In Durham's fatal case there were signs of bruising about the pancreas, and the aneurism was found to affect the mesenteric artery. The time during which the pressure has been maintained has varied considerably. Murray's case was cured by one application lasting five hours; Durham and Moxon's in 10½ hours; Greenhow and Hulke's, by three applications lasting 55 minutes, 4 hours, and 3 hours. In Marshall's case distal pressure was applied without serious consequences, on one occasion for 18 hours, and on another for 19 hours. Vomiting has been found to be a troublesome complication in several cases. Of the successful cases, Murray's is the only one in which the pulsation of the tumour ceased permanently immediately after the operation. In Greenhow and Hulke's case it did not finally disappear till some days after the last application of the tourniquet; and in Durham and Moxon's, although it ceased at the time, it returned in a few hours, and persisted for a month before it finally disappeared. From the above cases, it will be seen that there is sufficient probability of success to justify us in adopting the *proximal* operation in every favourable case. Further evidence is required before abandoning *distal* pressure as absolutely useless. In Bryant's fatal case the sac was found to be filled with firm clot, which was considered to have been sufficient, had the patient lived, to have cured the aneurism. In Marshall's case the tumour was thought to be slightly more solid after the operations, but no permanent effect was produced. The distal operation, however, does not seem a very hopeful one. The number and size of the branches coming off from the aorta at its upper part, and the frequency with which the cœliac axis and its large branches are implicated, are very unfavourable circumstances for distal pressure. The anastomosis of the collateral vessels is, moreover, so small compared to the immense interference with the direct circulation, that the only effect of distal pressure must be for many hours greatly to increase the tension in the vessels above.

In performing the operation of compression of the aorta under prolonged anæsthesia, a few points require special attention. The patient should be fed well on the day before the operation. On the day of the operation he should receive fluid nourishment only, and the bowels should be well emptied by means of a copious enema. The tourniquet must be applied with the greatest care immediately above the tumour, and with no more force than is absolutely necessary. If much force be required before the pulsation in the femoral arteries is arrested, it is probable that the pad of the tourniquet is not in the right place, and various attempts must be made till the spot is found where the smallest amount of pressure will control the circulation. It will be found convenient to insert a soft hollow sponge under the pad of the tourniquet, as it then accommodates itself more readily to the parts between it and the spine. During the operation the patient must be watched very carefully, and the tourniquet slackened at once if any symptoms of faintness supervene. Obstinate vomiting may render the continuance of the operation impossible. It is difficult to say whether this is due to pressure on the sympathetic or to the influence of the chloroform. During the application of the tourniquet, it is advisable to have the lower limbs raised in the bed and warmly wrapped in cotton-wool, as marked coldness and serious congestion have usually been noticed after the compressiun has lasted a short time. If necessary, nutritive enemata and brandy may be administered during the anæsthesia.

Abdominal aneurism has been treated in two cases by the introduction of foreign bodies into the sac after laparotomy, but without success (see p. 152).

INGUINAL ANEURISM.

An **Iliac** or **Inguinal Aneurism** may arise from the external iliac, or from the common femoral artery ; most frequently it springs from the latter, and, taking a direction upwards, pushes the peritoneum before it, and thus encroaches somewhat upon the cavity of the abdomen. The aneurism is commonly of the circumscribed false variety, though sometimes tubular. It rarely if ever, becomes diffused, for the reason long ago pointed out by Scarpa, that the femoral artery, above the edge of the sartorius muscle, is invested by so dense a sheath, and is so closely bound down to the neighbouring fascia, that, when dilated into an aneurism, it does not readily give way.

Symptoms.—When first noticed, the aneurism is a small, soft, compressible tumour, with pulsation and bruit, and is generally attended by little pain or uneasiness. It rapidly enlarges, however, and may attain a considerable magnitude ; being often somewhat lobulated upon the surface, owing to the unequal constriction exercised on it by the fascia under which it lies. At the same time, it usually becomes more solid ; and the pulsation in it diminishes considerably, or even ceases entirely. As it increases in size, it compresses the saphena and femoral veins, thus giving rise to œdema of the limb ; and, by stretching the genito-crural and some of the branches of the anterior crural nerve, it occasions considerable pain in the thigh and leg.

Diagnosis.—The diagnosis of inguinal aneurism is not always so easy as might at first appear. It has most frequently been confounded with abscess in the groin, and with soft pulsating sarcomata, in this situation. The diagnosis from *abscess* must be made on general principles ; but in some instances it appears to be replete with difficulty, as there are not a few cases on record in which aneurisms in this situation have been mistaken for abscesses and punctured, an error that has three times fallen under my own observation, and one which has in every instance proved fatal. The diagnosis of an inguinal aneurism, solidified by the deposition of laminated fibrin, and pulsating but indistinctly, from a *pulsating sarcoma* in the groin, is surrounded by the greatest difficulty, and cannot, I believe, with the means we at present possess, be accomplished with absolute certainty. The fact of these diseases having in two instances been confounded by two of the most distinguished Surgeons of their day, Stanley and Syme, is sufficient evidence of the difficulty attending the diagnosis.

Treatment.—It occasionally happens that inguinal aneurisms, even of a very large size, undergo spontaneous cure, or become consolidated by direct pressure conjoined with constitutional treatment; but this has so rarely occurred, that such a result cannot be relied on in any one case.

Treatment by Compression has been successfully adopted in aneurism of the iliac arteries. Digital compression has been employed in several cases, but more commonly the pressure has been applied by Lister's abdominal tourniquet Carte's compressor, Signorini's tourniquet or weights. In some cases the proximal pressure has been supplemented by distal compression of the femoral, or by the application of Esmarch's bandage to the limb. In whatever way the treatment is carried out, Murray insists on the importance of complete arrest of the flow of blood through the sac. It is usually necessary to administer an anæsthetic during the treatment. The time required for consolidation in the successful cases has varied considerably. Thus, one of Murray's cases was cured in three-quarters of an hour, and one of Heath's (of Newcastle) in twenty minutes. In one under the care of Lawson, in which two tourniquets were applied—one to the abdominal aorta and one to the femoral below the sac—that on the aorta had to be removed at the end of twenty minutes, owing to collapse and vomiting; the femoral one being maintained in position. When the abdominal compressor was removed the pulsations had already diminished, and at the end of four hours they ceased, the patient making a good recovery. In other cases it has been necessary to continue the treatment intermittingly

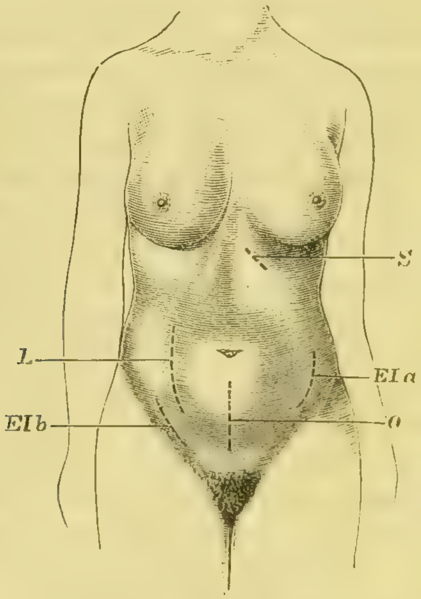


Fig. 492.—Diagram showing the incisions in the following operations: *EIa.* and *EIb.* Ligature of External Iliac according to Abernethy and according to Cooper. *L.* Abdominal Nephrectomy. Langenbach's incision. *O.* Ovariotomy. *S.* Gastrostomy.

for several days. Walsham has collected fifty-eight cases of inguinal aneurism from British and American sources occurring between 1870 and 1885. Treatment by pressure was adopted with success in 10. In 2 more the pulsation ceased, but the patients died shortly afterwards from rupture of an aortic aneurism. In 2 the treatment was directly the cause of death. In the remaining 23 the artery was ligatured after pressure had failed, and in twelve of these Walsham is of opinion that the previous compression had rendered the conditions of the operation materially worse. These statistics show that in well selected cases compression holds out a fair prospect of curing the disease and should be tried before resorting to ligature, but care must be taken not to damage the vessel or the parts covering it by too prolonged and forcible efforts to obtain consolidation by that means. Should it fail, it becomes necessary to tie the vessel leading to the sac. In the majority of instances the tumour, though it may have encroached on the abdomen, will not have reached too high for the external iliac to be ligatured; should it have done so, however, the Surgeon may have to tie the common iliac artery; but in some instances even this may not be practicable, and his choice must lie between the slender chance offered by constitutional treatment, and the fearful alternative of ligaturing the aorta.

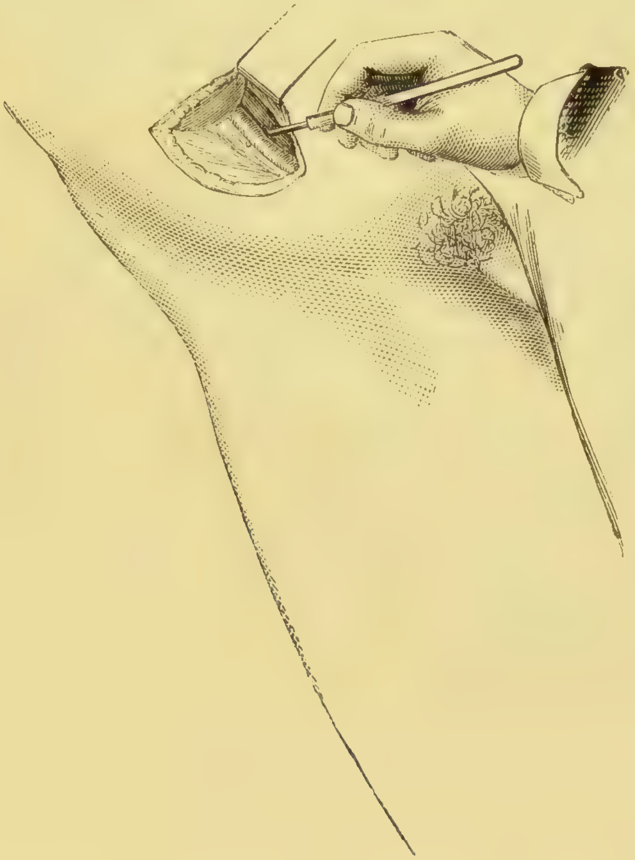


Fig. 493.—Ligature of the External Iliac by Abernethy's Operation, modified.

Ligature of the External Iliac Artery.—There are two modes of tying the external iliac artery—the one originally practised by Abernethy, considerably modified by Liston; and the other introduced by Sir A. Cooper.

Abernethy's modified method (Fig. 493) on the right side consists in commencing an incision at a point about one inch above and the same distance internal to the anterior superior spinous process of the ilium, carrying it in a curved direction, with the convexity outwards, to a point about three-quarters of an inch above and half-an-inch external to the middle of Poupart's ligament. When the operation is on the left side the incision should be commenced below and carried upwards between the two points mentioned. The wound thus made is altogether external to the inguinal canal and to the line of the epigastric, and above and internal to the main trunk of the circumflex iliac artery. It is about four inches in length, and, if necessary, in fat subjects may be extended at the upper end. After cutting through the skin and superficial fascia, the tendon of the external oblique is carefully divided, as much as possible in the line of its fibres. The internal oblique and transversalis are next divided with great caution, when the transversalis fascia is reached, and recognized by its dull white appearance. Beneath this membrane there is often a little fat, especially at the lower part of the wound. A small portion of the fascia, at the lower end of the wound, is now carefully raised with the forceps, and cut through with the blade of the scalpel laid on the flat. A broad hernia-director is then introduced, and passed underneath it, when it should be laid open to the full extent of the wound. In doing this care must be taken not to wound the peritoneum. This is most likely to happen in consequence of a fold of that membrane overlapping the end of the director, so that the knife wounds it when run along the groove. To avoid this it is safer not to push the knife quite to the end of the director. The risk of wounding the peritoneum may be also avoided by tearing the transversalis fascia with the fingers instead of using the knife. Both the fascia transversalis and fascia iliaca are firmly attached to Poupart's ligament, so that there is no risk of stripping up the latter fascia in such a way as to displace the vessels. If a hole be made in the fascia transversalis large enough to admit the tips of the two forefingers, it will be found always to tear with the greatest ease to the full extent of the wound. When this is accomplished the whole inner side of the wound is drawn inwards and slightly downwards, the peritoneum being gently separated from its loose areolar connections in the iliac fossa by the Surgeon's fingers ; it must be kept out of the way by an assistant, who holds it up with a broad bent copper spatula. The artery will now be felt pulsating at the brim of the pelvis, and is readily brought into view at the bottom of the wound. It is enclosed in a very loose areolar sheath, and has the vein lying to its inner side and the genital branch of the genito-crural upon it. It is crossed near Poupart's ligament by the circumflex iliac vein. The investing areolar tissue must be scratched through, and the needle passed from the inner side between the vessels. When the artery is much diseased, it is often very tortuous, and may dip down into the pelvis so as to make it difficult to expose it except close to its lower end. Occasionally enlarged glands round the artery give some trouble by obscuring it and rendering it difficult to clean.

In *Sir Astley Cooper's operation* the outer two-thirds of the inguinal canal are opened. An incision is made about three inches in length, beginning close to Poupart's ligament, about half an inch outside the external abdominal ring, and terminating about one inch internal to the anterior superior spinous process of the ilium. The line of incision is not quite parallel to Poupart's ligament, but rather to the fibres of the aponeurosis of the external oblique. In dividing the superficial fascia, the superficial epigastric artery is cut and must be ligatured. The external oblique having been exposed, a small hole is made through the aponeurosis at the lower end of the wound, and a director inserted, on which it is divided to the full extent of the wound, taking care to cut exactly parallel to the fibres so as to injure the tendon as little as possible. The knife may now be laid aside, the subsequent steps of the operation being carried out with a steel director and the forceps. The divided aponeurosis of the external oblique being held open with blunt hooks, the cord, surrounded by the cremaster, and the lower edge of the internal oblique come into view. Some loose areolar tissue and a few fibres of the cremaster must now be scratched through, close to Poupart's ligament, and the finger passed beneath the cord, which must be pushed upwards. The transversalis fascia is then carefully torn through with the director and forceps, and the artery can then be felt covered by a little fat and areolar tissue. Two copper spatulæ are then inserted through the opening in the transversalis fascia ; the internal of these is drawn upwards and inwards, raising the cord and drawing the epigastric artery out of the way ; the external pulls the lower border of the internal oblique and of the transversalis upwards and outwards. Both spatulæ raise the peritoneum. By clearing away a little loose areolar tissue, the artery can be exposed for one inch and a half or two inches without difficulty. It has the genital branch of the genito-crural lying on it, and it is crossed by the circumflex iliac vein a little above Poupart's ligament ; the external iliac vein is to its inner side ; these must be carefully avoided. The needle must be passed from the inner side not less than one inch above Poupart's ligament, so as to avoid the epigastric and circumflex iliac arteries. After the operation a drainage-tube may be inserted at the lower angle of the wound, and a catgut suture inserted in the divided tendon of the external oblique.

On comparing the two operations, it would appear that the principal disadvantage of Abernethy's is, that it is apt to leave a tendency to hernial protrusion, in consequence of the abdominal wall being much weakened by the free incisions that are necessary through the muscular planes ; the great advantage attending it is, that the external iliac may be ligatured at any part of its course, and that, if requisite, the incision may be extended upwards, and the common trunk secured. In Sir A. Cooper's operation, the line of incision lies directly across the course of the epigastric artery, which, as well as the circumflex iliac, if it arise high, and the circumflex iliac vein which crosses the iliac artery at this point and is often somewhat funnel-shaped, may be in danger of being wounded. The spermatic cord is likewise somewhat in the way in this operation. Dupuytren actually wounded the epigastric artery in one case ; and Houston had much difficulty from the circumflex vein in another instance. This operation has also the disadvantage, that the incision upwards cannot be conveniently prolonged so as to deligate any portion of the vessel except that which lies immediately above the crural arch ; but the peritoneum is less disturbed than in the other case, and there is less tendency to hernial protrusion afterwards. As a general rule, I think we may conclude that, in cases of spontaneous aneurism, in which it might, from the size of the tumour or the diseased state of the vessels, be found necessary to apply the ligature to a higher point than was intended before the operation commenced, it will be safer to have recourse to Abernethy's plan, modified as above described, for in this way we shall be able to ligature the vessel at any part of its course; whilst in cases of hæmorrhage after amputation, or of traumatic femoral aneurism, in which the artery is not likely to be diseased, recourse should be had to Cooper's operation, more particularly if the patient be thin, and the abdomen flat.

In connection with the ligature of the external iliac artery, there are some practical points that deserve mention. Before the operation, the colon should be emptied by means of an enema, and the pubes shaved. The incision in the abdominal wall must be sufficiently extensive.

In Abernethy's method, modified as above described, there is no fear of wounding the epigastric unless the incision be carried too far at its lower end. The artery may be roughly said to run in a line drawn from the point at which the femoral artery crosses the brim of the pelvis to the umbilicus. In neither method of operating should the incision implicate the external ring, lest it give rise to a tendency to hernial protrusion. Care should be taken not to wound the peritoneum; for, although with efficient antiseptic treatment there is little danger in so doing, yet it is better, if possible, to avoid it. The peritoneum must not be torn up more than is absolutely necessary, lest hæmorrhage or subsequent peritonitis occur. In raising the peritoneum, care must be taken not to displace the artery which lies loosely in the subperitoneal tissue, and can be easily raised in the spatula, or pushed over the brim of the pelvis. The separation of the peritoneum is much facilitated by the Surgeon holding the outer cut edge of the transversalis fascia tightly in his forceps with one hand, whilst with the other he gently raises the bag of the serous membrane out of the iliac fossa, and separates its areolar connections there. All this must be done with the utmost gentleness and care. Before attempting to pass a ligature round the vessel, the thin fascia covering it must be scratched through; and the areolar connections with the vein, which are very thin and loose, must be separated by means of a director, or the end of the aneurism-needle. The artery must be well cleared, and especial care taken that the genital branch of the genito-crural nerve is not included in the noose. It is better not to use the knife deep in the wound. Lastly, the sac if it extend high, must not be weakened by having its peritoneal covering stripped off.

Results.—Ligature of the external iliac was first practised by Abernethy in 1796. During the following fifty years there were 100 recorded cases of the operation for inguinal aneurism (Norris); of these 73 were cured and 27 died. Rabe's statistics, with 30 cases added by Barwell, give 141, with 31 deaths, or nearly 22 per cent.

Among the cases collected by Norris is one in which both external iliacs were ligatured successfully at an interval of eleven months by Tait.

In some few cases also, there was the complication of an aneurism in the ham with that in the groin. Of ninety-two cases in which the aneurism was seated solely in the groin, seventy were cured and twenty-two died. Death resulted from gangrene of the limb in eight, from secondary hæmorrhage in four, from sloughing of the sac in three, from tetanus in three, and from causes of a more general character in four cases.

Pulsation returned in the sac in six of the cases collected by Norris; in some not until several weeks had elapsed after the operation; and in one instance only was it followed by death. *Suppuration of the sac* was of frequent occurrence, happening in thirteen instances, doubtless owing to the large size of the tumour and to septic suppuration in the wound, which must necessarily in such cases be in close proximity to the sac. It is remarkable, however, that in three cases only was this accident fatal; and in two of these the sac had been opened before the operation, on the supposition of its being an abscess. *Secondary hæmorrhage* occurred in but six cases, four of which proved fatal; a very small proportion when compared with what happens in other situations. This must doubtless be attributed in a great measure to the absence of any collateral branches springing from the trunk of the external iliac; the distance between the point ligatured and the epigastric and circumflex iliac arteries affording abundant space for the safe obliteration of the vessel. In one of the fatal cases, pulsation had previously returned in the sac; in the other three the patients died on the seventeenth, the twenty-seventh, and the forty-third days respectively.

Gangrene of the limb was the most common cause of death in Norris's tables. It occurred in nine instances, of which eight proved fatal; one being cured by amputation. The period at which the mortification supervened varied from the third to the fourth week. The principal cause of this gangrene is narrowing or obliteration of the neighbouring venous trunk, by pressure of the tumour. In the accompanying woodcut (Fig. 494) this is well illustrated; the vein opposite the aneurism being completely closed.

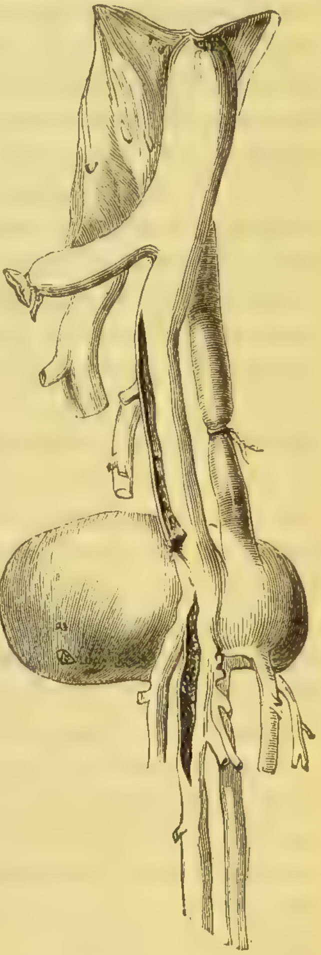


Fig. 494.—Obliteration of Femoral Vein by Inguinal Aneurism.

It is a very remarkable circumstance in the history of this operation, that four deaths resulted from *tetanus*. This sequence of this particular operation is difficult to account for, as it is a most unusual occurrence after the ligature of arteries, and is equally rare after wounds of the abdominal wall in other operations, as for hernia. The possible explanation that offers itself is that in these cases the genito-crural nerve, or its genital branch, may have been unduly irritated by or implicated in the ligature.

Rabe's statistics with Barwell's supplementary cases give somewhat different results. Hæmorrhage occurred in 24 of the 141 cases: of these 9 recovered and 15 died. Gangrene was fatal in 6, peritonitis in 2, retroperitoneal suppuration in 2, and various other causes in the remaining 6, making a total of 31 deaths in the 141 cases.

The ligature of the external iliac for *aneurismal varix in the groin* affords a striking contrast with that for spontaneous aneurism; the four cases recorded all proving fatal, two dying of gangrene, and two of hæmorrhage. In these cases Guthrie has recommended that the tumour should be laid open, and the artery ligatured above and below the aperture in it. During the operation the artery may be readily commanded above the seat of disease by the application of the abdominal tourniquet, either to the aorta or to the common iliac at the brim of the pelvis.

Aneurism occasionally takes place *in the groin and ham of the same side*; here the ligature of the external iliac will cure both diseases. Of four cases in which this complication occurred, the operation was successful in three, one patient dying of gangrene; and in him the popliteal aneurism was on the point of bursting at the time of the operation. In two of the three cases that recovered, pulsation returned in the inguinal aneurism, but disappeared after a time.

Ligature of the Common Iliac.—This artery was first tied by Gibson in a case of gunshot injury, the patient dying of peritonitis and secondary hæmorrhage on the thirteenth day. The great American Surgeon, Mott, was the first who tied it for aneurism, the patient making a good recovery. If the aneurism in the groin extend so high that there is not sufficient space for the exposure and ligature of the external iliac artery, it becomes necessary to tie the common trunk. This may be done by extending the incision that serves for the ligature of the external iliac upwards and slightly inwards towards the umbilicus, to an extent corresponding to the degree of obesity of the patient, so that it assumes a somewhat semilunar form. If the operation is commenced with the intention of applying a ligature to the main trunk, it is of great importance in determining the length of the incision, and calculating the point at which the artery will be met with to remember the *different bearings of the parts in the neighbourhood of the vessels*, and the *relative frequency with which the origin and termination of the artery correspond with certain fixed points* that may readily be detected.

The points of importance are the relations of the vessels to the lumbar vertebræ, to the crest of the ilium, and to the umbilicus. The ordinary place of division of the abdominal aorta is on the body of the fourth lumbar vertebra, or on the intervertebral disk below it; according to Quain, this was the case in four-fifths of the bodies he examined, or in 156 out of 196. In regard to the relations between the situation of the bifurcation of the aorta and the crest of the ilium, we find it, according to the same anatomist, to have ranged in about four-fifths of the cases between half an inch above and below the level of the highest point of this part of the bone. With reference to the umbilicus, no definite rule can be laid down; but it may be broadly stated that the bifurcation of the aorta is a little to its left. As a general rule, that given by Hargrave is perhaps sufficiently good for ordinary purposes. If a point be taken about half or three-quarters of an inch below and a little to the left of the umbilicus, and a line be drawn on each side from this to another point midway between the symphysis pubis and the anterior superior iliac spine, we obtain about the direction of the common and external iliac arteries. On dividing these lines into three equal parts, the upper third will correspond to the common trunk, and the lower two thirds to the external iliac, and the junction of the upper with the middle third to the bifurcation of the common iliac artery.

The point of bifurcation of the common iliac artery is, in the majority of cases, opposite the lumbo-sacral articulation; and if it be not in this situation the division will probably be lower down. The length of the vessel varies greatly; according to Quain, in five-sevenths of the cases it ranged between one-and-a-half and three inches.

The artery lies at the brim of the pelvis. The veins on the two sides differ in their relation to the arteries. The left vein lies to the inner side of the left artery, and then passes beneath the right common iliac artery to join the right vein in forming the vena cava inferior. On the right side the vein is at first beneath and then to the outer side. The common iliac artery is crossed by the ureter near its lower end.

The incision to expose the common iliac extends from a point about one inch external to and one inch above the middle of Poupart's ligament in a curved direction to another point about two inches above and the same distance internal to the anterior superior iliac spine. The curve must be such that if prolonged the incision would reach a point about midway between the xiphoid cartilage and the umbilicus. Care must be taken that the incision be not carried too low down or too far forwards; nothing can be gained by doing so, and there is besides the additional risk of the circumflex iliac or epigastric being wounded, as happened to Mott; and as these are the principal agents in the anastomosing circulation their injury is a serious accident. The muscles are carefully divided, as in the operation for tying the external iliac, and the transversalis fascia opened in the same way. The peritoneum now comes bulging into the vound, pressed forward by its contents. It must be gently stripped from the iliac fossa by the Surgeon carefully insinuating his hand beneath it, care being taken to raise it directly inwards towards the brim of the pelvis, at which point the external iliac will be found, which serves as a guide to the parent trunk. The ureter always comes up with the peritoneum, and is usually not seen. The peritoneum must be well drawn inwards by broad copper spatulæ. The ligature must be passed round the artery on the left side from within outwards, a slight scratch having been made through the fascia covering the vessel by means of the finger-nail, by which it may also be separated from the accompanying vein. On the right side great caution must be used, on account of the position of the left vein beneath the artery and the right to its outer side. In the later stages of the operation, the patient should be turned on his sound side in order to prevent the intestines from falling over and pressing the peritoneum into the wound.

Since laparotomy, performed with proper antiseptic precautions, has come to be regarded as almost free from danger, it has been suggested that the common iliac artery might be more easily reached from within the peritoneal cavity. Fluhrer has operated by this method in one case, the abdomen being opened by an incision in the middle line. The patient died on the 7th day of "acute nephritis." Some circumscribed peritonitis was found about the seat of ligature.

Results.—The earlier cases of ligature of the common iliac for aneurism were singularly successful, 7 out of 11 recovering up to 1852. Since that time the operation has been frequently repeated, but with less satisfactory results. Stephen Smith in 1860 collected the records of 32 cases in which this artery had been tied, of which only 8 recovered. Agnew in 1878 gives a table of 62 cases, of which 50 died and 12 recovered; but Kümmell in 1884 considered only 55 to be recorded with sufficient accuracy to justify their being included in a statistical table. Of these 41 died and 14 recovered; in 16 the artery was tied for hæmorrhage, and of these 13 died; in 32 for aneurism, with 22 deaths, and in the remaining 7 for vascular tumours and other causes, and of these 6 died. Since that time the common iliac has been tied once successfully by Jameson, who exposed the right artery by an incision on the left side, believing that it can be reached more easily in this way, and once unsuccessfully by Fluhrer, who exposed the vessel by laparotomy. Gangrene has been a very rare cause of death after ligature of the common iliac.

The **Old Operation** has been performed in more than one case of iliac aneurism, when from special circumstances it was not possible to tie the artery above the sac. In Syme's well-known case the sac was laid open and three ligatures applied, which were believed to include the external, internal, and common iliac arteries. The patient practically recovered, but died of pleurisy after some months, before leaving the hospital. The *post-mortem* examination showed that the ligatures had been placed on the external iliac only. Sir Astley Cooper attempted the same operation in the case in which he subsequently tied the aorta. Heath laid open the sac of an iliac aneurism which had been opened by mistake for an abscess before being admitted into University College Hospital. The external iliac was tied from within the sac, but the patient died from secondary hæmorrhage. The old operation can only be performed with safety when it is possible to compress the aorta above the sac; and consequently, as Holmes points out, an attempt should be made to effect a cure by compression before so dangerous an operation is attempted.

Ligature of the Aorta.—It is impossible not to contemplate with admiration the man whose mind was the first to conceive, and whose hand was the first to carry out, the determination to apply a ligature to the abdominal aorta; and who, guided by pathological observation and physiological experiment, ventured to arrest at once the circulation through the main channel of supply to the lower half of the body, trusting to the collateral circulation for the maintenance of the vitality of the parts thus suddenly deprived of blood. Sir A. Cooper was the first to place a ligature on the aorta, in 1817. Since that period the operation has been six times performed for aneurism; viz., by James, of Exeter; by Murray, at the Cape of Good Hope; by Monteiro, at Rio Janeiro; by South, of London; by McGuire, of Richmond, U.S.; by Stokes, of Dublin; and once, in circumstances which will be presently described, by Czerny.

TABLE OF CASES OF LIGATURE OF ABDOMINAL AORTA FOR ANEURISM.

SURGEON.	SEX.	AGE.	DATE.	NATURE OF ANEURISM.	OPERATIONS.	RESULTS.
1. SIR A. COOPER.	M.	38	1817	Diffused Inguinal	Incision through Peritoneum.	Death in 40 hours.
2. JAMES.	M.	44	1829	External Iliac.	Distal ligature first: Peritoneum opened.	Death in a few hours.
3. MURRAY.	M.		1834	Inguinal.	Aorta tied behind Peritoneum.	Death in 24 hours.
4. MONTEIRO.	M.		1842	Diffused Inguinal	Aorta tied behind Peritoneum.	Death on 10th day.
5. SOUTH.	M.	28	1856	Common Iliac.	Aorta tied behind Peritoneum.	Death in 43 hours.
6. MCGUIRE.	M.	30	1868	Lower part of Aorta, both Common Iliacs, and Left External Iliac.	Aorta tied behind Peritoneum.	Death in 12 hours.
7. W. STOKES.	M.	50	1869	Iliac.	Aorta tied behind Peritoneum.	Death in 13 hours.

In Sir A. Cooper's case, the inguinal aneurism had burst, and the aorta was tied about three-quarters of an inch above its bifurcation, by making an incision three inches in length through the abdomen, a little to the left of the umbilicus, the fingers being passed between the coils of the intestines, and the peritoneum covering the artery being scratched through. The patient survived forty hours. James ligatured the aorta much in the same way as Sir A. Cooper, in a case in which he had previously employed the distal operation for an inguinal aneurism; but without success, the patient speedily dying. Murray ligatured the vessel by making an incision on the left side, in front of the projecting end of the tenth rib, and carrying it downwards for six inches to the anterior superior spine of the ilium. The parts were then carefully divided to the peritoneum, which was separated from the iliac fossa and the psoas muscle, when, with great difficulty, and by scratching with the end of an elevator and the finger-nails, room was made for the passage of the ligature round the artery, which was tied three or four lines above its bifurcation. The patient died in twenty-three hours. The most interesting case on record is that by Monteiro, who tied the aorta for a large false aneurism on the lower and right side of the abdomen; here the incision was made much as in Murray's case, and the artery ligatured with great difficulty. The patient lived till the tenth day, when he died of secondary hæmorrhage. In South's case, the aorta was tied behind the peritoneum by an incision on the left side of the abdomen. The patient died in forty-three hours. McGuire's patient had an aneurismal tumour of the size of a goose's egg in the left iliac region. Digital pressure near the umbilicus was attempted, but could not be done. The operator's intention was at first to tie the left common iliac artery; but, finding the disease more extensive than he expected, he enlarged the incision and tied the aorta. The sac burst during the manipulation necessary to reach the aorta, and about a pint of blood was lost. The patient died in eleven hours. Stokes compressed the aorta with a silver wire passed round it in the way of a ligature. He made a crescentic incision five-and-a-half inches in length in the left side of the abdomen, extending from an inch below the tenth rib to the middle of Poupart's ligament. The abdominal muscles and fascia transversalis were then incised, and the peritoneum exposed and drawn out of the iliac fossa. It was accidentally, but only slightly wounded. The patient being turned on his right side, the arteries and the aneurism were exposed, and the wire passed by means of an aneurism-needle round the aorta immediately above its bifurcation. The patient died in twelve hours. Perhaps the most interesting point in this remarkable case is the fact of the pulsation returning in the left (sound) femoral artery nine hours after the operation; showing how rapidly the collateral circulation can be re-established. Czerny's case scarcely belongs to the present category, but may be mentioned here. The patient was a French soldier, the upper part of whose thigh had been shattered by a ball during the Franco-German war. Secondary hæmorrhage occurring, Czerny tied the common femoral, and also the superficial femoral below the origin of the profunda. This arrested the hæmorrhage for a time; but in six days it recurred. Czerny then tied the common iliac; but, as the hæmorrhage continued, he thought that he had tied the external iliac, and proceeded to apply another ligature—which he placed by mistake on the aorta. The patient survived twenty-six hours. In this case too, twenty-two hours after the operation, the injured limb was cold and as if dead, while the opposite limb was warm, and retained sensation and motion.

In this operation, there are not only all the dangers attendant upon the ligature of arteries of the first magnitude, but also the risk of producing fatal peritonitis, whether the abdomen be cut through, or the vessel sought for by stripping up the peritoneum from the iliac fossa; and it appears to me that a patient suffering from an inguinal aneurism large enough to justify ligature of the aorta, would have a better chance of recovery, or rather of prolongation of life, by the adoption of proper constitutional treatment, together with pressure upon the tumour and the distal ligature or compression of the artery. Lister's aortic compressor might be applied in such cases, so as to moderate the flow of blood. Should the operation be again attempted, there is little doubt that the incision adopted by Sir A. Cooper would be the safest, as the danger of peritonitis is much less under the present modes of treatment.

ANEURISM OF THE INTERNAL ILIAC AND ITS BRANCHES.—Aneurism of the *Trunk of the Internal Iliac Artery* is extremely rare. The only case with which I am acquainted is one related by Sandifort. The three principal branches of this artery—the *Gluteal*, the *Sciatic*, and the *Pudic*—have all occasionally, though rarely, been found affected by this disease. Of these branches the gluteal has been most frequently found aneurismal, the sciatic next, and the pudic least frequently; indeed, I am acquainted with only one instance of aneurism of this vessel. It is the preparation 1701 in the Museum of the College of Surgeons; and it exhibits an aneurism of the trunk of the pudic nearly an inch in diameter, full of laminated clot.

Aneurisms of the Gluteal and Sciatic Arteries may be either traumatic or spontaneous.

Fischer of Hanover has published with comments, in the *Archiv für Klinische Chirurgie*, the records of thirty-five cases of gluteal and sciatic aneurism; to which must be added a case of gluteal aneurism described by Gallozzi of Naples, one by Bickersteth of Liverpool, and three by Dennis. In twenty-seven of Fischer's cases the aneurism was distinctly gluteal, in six distinctly sciatic, and in two the origin was uncertain. Thirteen of the gluteal aneurisms, and two of the sciatic, were of traumatic origin; fourteen gluteal and four sciatic aneurisms were spontaneous. The gluteal aneurism has been generally found situated on the upper part of the great sciatic notch; but it may extend over a large portion of the buttock. Sciatic aneurism lies more deeply; and a portion of the sac may be within the pelvis. The size of these aneurisms varies from a slight swelling to a tumour as large as a child's head. In almost all the recorded cases there has been strong pulsation, with whirring and buzzing murmurs heard on auscultation. There is almost always pain in the tumour itself and in the course of the sciatic nerve, which may be followed by paralysis of the parts supplied by it.

The affections with which these aneurisms are most likely to be confounded are abscesses, soft sarcomata, cysts, and sciatic hernia. The diagnosis is sometimes difficult; thus Guthrie ligatured the common iliac artery for a large pulsating tumour in the gluteal region, which presented all the characters of aneurism, but which proved, on the death of the patient eight months after the operation, to be a sarcoma. The diagnosis may be facilitated by examination through the rectum, as the sac may lie partly in the pelvis.

Gluteal aneurisms have on several occasions been opened by mistake for abscesses. According to Holmes, this accident has most frequently happened when the aneurism has been more or less diffused, and in such cases he suggests that the aspirator should be used to render the diagnosis certain.

In the **Treatment,** various methods have been employed. *The sac has been laid open* and the gluteal artery tied in five cases, all of which recovered. In another instance, after laying open the sac, the aneurism (gluteal) was found to extend into the pelvis ; and the internal iliac artery was tied, with a fatal result. *Ligature of the internal iliac artery* has been performed in fourteen cases, eight of which recovered. *The common iliac artery* has been tied in three cases, all of which proved fatal. *Injection of the perchloride of iron* has been used in six cases ; four recovered, one died, and in one the result is not known. *Ligature of the sciatic artery* without opening the sac has been performed in two cases, one of which recovered. Spontaneous recovery is reported to have occurred in one case.

Ligature of the Internal Iliac.—This vessel was ligatured for the first time in 1812. The operation was performed by Stevens of St. Croix, on a negress who suffered from an aneurism of the nates, supposed to be of the gluteal artery, but found after death three years subsequently to take its origin from the sciatic. Stevens in this case made an incision five inches long on the left side of the abdomen, carefully dissected through the parietes, separated the peritoneum from the iliac fossa, turned it on one side, together with the ureter, and passed a ligature round the artery without much difficulty. Since that time the operation has been done twenty-three times ; in eight cases with success, by Arndt, White, Mott, Syme, Morton, Gallozzi, Chew and Dennis ; in fourteen cases unsuccessfully, by Atkinson of York (whose patient died on the nineteenth day, of secondary hæmorrhage), by Bigelow, Torracchi, Cianflone, Porta, Landi, Kimball, Altmüller, Thomas, J. K. Rodgers, Higginson and Dennis ; and three times by the Surgeons in the American Civil War.

The success that has hitherto attended this operation is certainly remarkable, when we take into consideration the depth at which the artery is situated and its great size ; it may, I think, be accounted for in part by the fact that, although in these cases the patient runs the ordinary risk attendant on the ligature of the larger pelvic arteries from the exposure and handling of the peritoneum, yet he is saved from danger resulting from the supervention of gangrene ; the anastomosis being so free, and the course traversed by the blood so short, that no difficulty can arise in the maintenance of the collateral circulation.

The steps of the operation necessary for the exposure of the internal iliac artery are precisely analogous to those requisite for the ligature of the common trunk. When the vessel is reached, it must be remembered that both the external and internal iliac veins are in close relation to it ; the one being to its outer side, the other behind it. As these vessels are large, and their coats thin, it is necessary that they should be separated by the finger-nail, or the blunt end of the aneurism-needle, before the ligature is passed round the artery ; care must be taken also not to put the vessel too much on the stretch in applying the ligature, lest the ilio-lumbar artery be ruptured. There is little risk of including the ureter which crosses the artery internally as it always adheres firmly to the peritoneum and is pushed on one side with it. As the length of the artery varies much, usually ranging between one and two inches, and as when it is short it has a tendency to be placed deeply in the pelvis, it would, I think, be more prudent, and occasion less chance of secondary hæmorrhage, for the Surgeon to ligature the common trunk.

As in the case of the common iliac, it has been suggested that the artery could be more easily reached by opening the abdomen in the middle line. This has been put in practice three times. In the first case, Dennis opened the abdomen and applied a cat-gut ligature to each internal iliac artery in a case of double gluteal aneurism. The intestines were held on one side by warm sponges and cloths, and the arteries easily exposed by dividing the peritoneum covering them. The operation lasted about 30 minutes. The patient, a female, never completely rallied from the operation, and died on the fourth day from suppression of urine. There was no peritonitis. In the second case, Chew opened the abdomen in the line of the usual incision for ligature of the internal iliac, and the patient, a negro aged 46, rapidly recovered. In the third case, Dennis successfully tied the artery, opening the abdomen in the linea alba. This method seems to present some advantages over the old operation, and with proper antiseptic precautions should not be accompanied by greater danger.

FEMORAL AND POPLITEAL ANEURISMS.

We have, in the preceding section, considered aneurisms affecting the groin, which are by no means unfrequent. Aneurisms of the thigh are much rarer; but those in the ham are very commonly encountered. Thus out of 551 cases of aneurism recorded in the British medical journals of the present century, Crisp has found that 137 affected the popliteal, and only 66 the femoral artery. Of these 66, 45 were situated either in the groin or upper part of the thigh, and 21 only were truly femoral or femoro-popliteal. The reason of this difference in the frequency of the occurrence of aneurism in different parts of the vessel, may be accounted for by its anatomical relations. In looking at the main artery of the lower extremity, in its course from Poupart's ligament to where it terminates in the anterior and posterior tibials, we see that it may be divided in relation to the muscular masses that surround it, into three principal portions: 1. That which is situated between Poupart's ligament and the inner margin of the sartorius, and which may be considered *inguinal;* 2. That which intervenes between this point and the aperture in the adductor tendon, and which may be considered *femoral;* and, 3. That division of the vessel which corresponds to the ham, and which may be considered *popliteal.* Of these three divisions, the first and last are comparatively superficial, and, being unsupported by muscle, readily expand; while the central portion of the artery is closely surrounded on all sides by muscular masses, and is very unlikely to be dilated into an aneurismal tumour. We find also that the inguinal portion of the vessel is closely and firmly invested by a dense and resistant fibro-areolar sheath, and is well supported by the fascia lata; whilst in the popliteal space the artery is surrounded merely by the ordinary areolar sheath, and receives no aponeurotic support. This difference in the connections of these two parts of the vessel may, to a certain extent, explain the greater frequency of aneurism in the ham than in the upper part of the thigh.

Aneurism of the Deep Femoral Artery is of extremely rare occurrence: indeed, I am acquainted with only six cases. One of these occurred in a young man under my care in University College Hospital in 1870. There was a large tumour at the upper part of the thigh, over which lay the superficial femoral artery, pulsating freely. The disease was cured by compression of the common femoral artery, hydrate of chloral being given to relieve pain. Another case is recorded by Bryant as having occurred in the practice of Cock at Guy's Hospital. The aneurism was situated at the origin of the deep femoral artery ; the external iliac was tied, but the patient died nine weeks after the operation. Fig. 495 is taken from a patient who died of pneumonia shortly after admission into University College Hospital. On examination after death, a large tumour of the thigh, which had not been very closely examined during life, proved to be a circumscribed false aneurism apparently arising from rupture of a perforating artery, most probably the consequence of embolism (Univ. Coll. Museum, 1274). Two cases are recorded by P. Marshall and J. Watson. Another has recently occurred under the care of C. H. Golding-Bird. The tumour had been noticed for three months and had been rapidly extending for five weeks. It filled the front and inner side of the upper third of the thigh, and extended for three inches into the iliac fossa. The external iliac and common femoral were pushed inwards for two inches. The external iliac was tied but the patient died on the fifth day of pneumonia. In the case which was under my care in the Hospital, the disease was recognized by the following signs, which are characteristic of it : 1. A large tumour extended from three inches below Poupart's ligament to the middle of the thigh, raising and slightly separating the adductor muscles and the rectus femoris. 2. All the ordinary aneurismal signs were present in this tumour—the most marked being a peculiarly loud and harsh bruit, and a dry forcible thrill. 3. The superficial femoral artery could be felt running over the anterior and inner aspect of the tumour, but clear of, and distinct from it. 4. The pulsation in the popliteal and its divisions was strong and perfect. 5. All the aneurismal signs ceased on compressing the common femoral artery, and returned on removing the pressure.

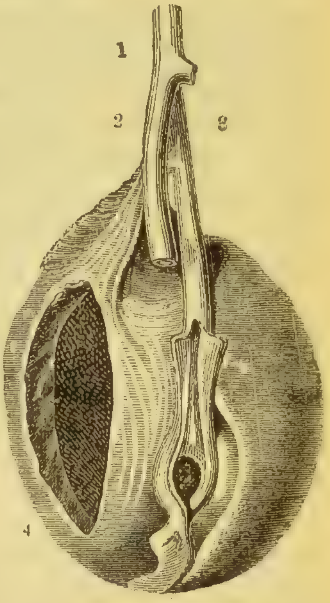


Fig. 495.—False Aneurism of a Perforating Artery.
1. Common Femoral.
2. Superficial Femoral.
3. Deep Femoral.
4. Aneurism, cut open.

The only disease with which an aneurism of the deep femoral artery can readily be confounded is pulsating sarcoma of the femur. The diagnosis from this must be left to the surgical tact of the practitioner.

In the **Treatment** of these aneurisms, the Surgeon has the choice of three methods ; viz., compression in the groin, and ligature of the external iliac, or of the common femoral. If the common femoral ever should be ligatured for aneurism, this appears to me to be the case best suited for it. But the choice between the ligature of this artery or of the external iliac must in a great measure depend upon the Surgeon's judgment as to the relative expediency of either operation, and on the height to which the aneurism extends up the groin. But neither artery should be ligatured until compression has been fairly tried and has failed. This may be done digitally or by Carte's instrument, where the artery passes over the brim of the pelvis. It is especially likely to succeed in aneurism of the profunda, owing to the shortness of the trunk and the way in which it breaks up into many anastomosing branches. Hence there is not a free current of blood passing from one large vessel of entry to another of exit, but, as it is broken up and has to filter out through a number of minor vessels, its coagulation may readily be brought about. In the case treated by me, compression effected a cure in twenty-four hours, though the aneurism was very large and active.

ANEURISMS OF THE SUPERFICIAL FEMORAL AND POPLITEAL ARTERIES.—These occur commonly about the middle period of life, and are almost invariably met with in males, being at least twenty times more frequent in them than in women. Both sides are affected with equal frequency, and occasionally at the same time. According to Crisp, sailors would appear to be more liable to this variety of the disease than any other class. These aneurisms are most frequently sacculated ; in the ham they are always so, but in the thigh they are sometimes tubular.

Symptoms.—The symptoms of **Femoral Aneurism** present nothing peculiar ; the tumour usually enlarging with considerable rapidity, with all the characteristic signs of the disease, and assuming a pretty regular ovoid shape. **Popliteal Aneurism** usually commences with stiffness and a good deal of pain abont the ham and knee, which I have more than once seen mistaken for rheumatism ; in fact, so commonly does this happen that the Surgeon should never fail to pass his hand behind and examine the ham in every case of persistent "rheumatic" pain in the knee. There is also a difficulty in straightening the limb, which is generally kept semi-flexed. The tumour increases usually with great rapidity, and has a tendency to become diffused ; these conditions will, however, materially depend on the side of the artery from which it springs. When it arises from the anterior aspect, next the bone, it increases slowly, being compressed by the firm structures before it. In this case, however, there is the great danger that, by its pressure upon the bones and knee, it may give rise to caries and destruction of the joint. When it springs from the posterior part of the artery, where it is uncompressed, it increases rapidly, and may speedily become diffuse. The diffusion of an aneurism in this situation may take place in two directions. If it be femoro-popliteal, it may give way into the general areolar tissue of the thigh, the blood diffusing itself as high perhaps as Scarpa's triangle. When it is confined to the ham, it may give way either under the integuments and into the superficial structures of the limb, or else under the deep fascia of the leg, where it will compress the posterior tibial nerve and artery. In all cases, the diffusion of popliteal aneurism is likely to be followed by gangrene.

Diagnosis.—The diagnosis of popliteal aneurism has to be made from chronic abscess, from bursal enlargements, and from solid tumours. In distinguishing it from *chronic abscess* no serious difficulty will be experienced ; but it may happen that, when an aneurism has suppurated, considerable difficulty may arise in determining its true nature—whether it be merely an abscess or not. On such cases as these, the state of the circulation in the lower part of the limb will throw much light. *Bursal tumours,* often of large size and multilocular, are not unfrequently met with in the ham ; but I have never found any great difficulty in determining their true nature, their elasticity and roundness, together with their mobility and want of pulsation, being sufficiently indicative of their character. The most serious diagnostic difficulty may arise from confounding solidified aneurisms of the ham with *solid tumours,* of a sarcomatous character, springing from the tibia and femur ; and I have known one case of aneurism in this condition, in which amputation was performed on the supposition of its being a solid tumour (Fig. 451).

Treatment.—The treatment of femoral and popliteal aneurism may be conducted either by compression or by ligature of the vessel leading to the sac. As a general rule, for the reasons already stated, compression should be employed in preference to ligature ; but cases do arise in which, from the failure of compression, or for other reasons, it becomes necessary to ligature the femoral artery.

The Treatment by **Compression** is peculiarly applicable to these aneurisms, and indeed it is for them that it has chiefly been employed. I need, therefore, say nothing special about them here, but would refer the reader to Chapter XLIII., page 135, for a description of the subject.

Flexion of the knee, which may be considered a modification of compression, is applicable to these cases also, either alone or in combination with compression of the main trunk. It is peculiarly applicable in those cases in which the aneurism is situate entirely in the ham (see p. 147).

Ligature of the Common Femoral.—In looking at the femoral artery it might at first be supposed that the common trunk, situated superficially between Poupart's ligament and the origin of the profunda, would be the most convenient situation for the application of the ligature ; but experience has shown that deligation of the vessel here is by no means a successful operation, especially when undertaken for aneurism. This arises from the shortness of the trunk rendering it necessary to tie the artery in close proximity to the collateral branch that will constitute the most direct and immediate agent in the anastomosing supply,—viz., the deep femoral, so that the internal coagulum would not readily form. In addition to this, a number of small inguinal branches, the superficial epigastric and circumflex iliac, the superior and inferior external pudic, and very commonly one of the circumflex arteries of the thigh, more especially the internal, arise from the common trunk in its short course ; and these vessels, though small in size, constitute a source of great embarrassment to the Surgeon during the operation ; for, if wounded near their origin, they bleed most furiously, and are a cause of considerable danger afterwards, by interfering with the proper plugging of the vessel. The ligature of the common femoral has, however, several advocates, more particularly in Ireland, where the operation has of late years been done nine times, for wound and aneurism, with six recoveries and three deaths. The successful cases were as follows : Porter, sen., three ; G. H. Porter, one ; Smyly, one ; Macnamara, one. In the American war, however, the operation is reported to have been performed in eighteen cases with only four recoveries ; and Barwell states that out of thirty-one cases in which the artery was tied for aneurism, hæmorrhage occurred in eighteen, and of these twelve died.

The vessel may be reached by a vertical or a transverse incision ; of these the former is preferable. The incision commences at Poupart's ligament, at a point midway between the symphysis pubis and the anterior superior iliac spine, and is carried downwards in the line of the artery for about two inches ; the skin, fat, and superficial fascia are divided, and the lymphatic glands removed or turned on one side. The fascia lata is then divided, and the crural sheath exposed. This must be carefully opened over the artery, and the needle passed from the inner side. The femoral vein lies to the inner side, and the anterior crural nerve a short distance away on the other side. The origin of the branches is very uncertain ; the Surgeon must select that part of the vessel for ligature which is most distant from any branch.

The statistics of this operation are so unfavourable, especially when performed for aneurisms, and secondary hæmorrhage has been so frequent and fatal an occurrence, in several cases requiring ligature of the external iliac for its arrest, that I do not think it advisable to have recourse to this operation in preference to ligature of the external iliac ; and it may be laid down as a rule in surgery, that in all those cases of aneurism that are situated above the middle of the thigh, in which compression has failed and sufficient space does not intervene between the origin of the deep femoral and the upper part of the sac for the application of a ligature to the superficial femoral, the external iliac should be tied.

Ligature of the Superficial Femoral.—The superficial femoral artery, in its course from the origin of the deep femoral to the aperture in the tendon of the adductor, is divided by the crossing of the sartorius muscle into two portions of unequal length, which have different relations to neighbouring structures. The upper division of the artery, which lies above the inner margin of the muscle, is of most interest to the Surgeon, as it is in this part of its course that it is invariably ligatured in cases of aneurism. It is true that John Hunter, in the operation which he introduced for popliteal aneurism, exposed and tied the vessel in the middle third of the thigh ; but his example has not been followed by modern Surgeons, on account of the far greater difficulty in reaching the vessel here than in the first part of its course. The superficial femoral, where it lies in Scarpa's triangle, being covered merely by the common integument, the superficial fascia and the fascia lata, may be reached by as simple an operation as any that the Surgeon has to perform for the ligature of the larger vessels. The line to the artery is taken as follows : The leg is flexed and the thigh rotated outwards. The Surgeon marks a point exactly midway between the anterior superior spine of the ilium and the symphysis pubis. From this he draws a line to the most prominent part of the inner condyle of the femur. The point selected for tying the artery must be about five inches above Poupart's ligament, as the ligature will then be at a safe distance from the profunda, the lowest recorded point of origin of that vessel being four inches below the ligament. The incision (Fig. 496) is made in the line above indicated, and should be from three to six inches in length, according to the amount of subcutaneous fat. It must be so arranged that the point selected for the application of the ligature shall be in the middle of its length. The skin and superficial fascia having been divided, the fascia lata is exposed and opened to the same extent as the incision in the integuments ; the muscular fibres of the sartorius now come into view. If the incision have been made too far inwards, it is possible that the adductor longus may be exposed instead of the sartorius ; the error is readily recognised by observing the direction of the fibres, those of the adductor being downwards and outwards, and those of the sartorius downwards and inwards. The edges of the wound in the fascia being held apart with blunt hooks, the sartorius is seized in the forceps and drawn outwards, the fibres of the areolar tissue surrounding it being touched with the edge of the scalpel, if necessary, until its inner edge comes into view. If the operation be performed a little higher than usual, or if the sartorius be feebly developed, its inner edge may come into view as soon as the fascia lata is divided. The edge having been found, the muscle must be turned outwards and held on one side with a copper spatula. A little loose areolar tissue must then be cleared away from beneath it with the handle of the scalpel, and the sheath of the vessels comes clearly into view. The sheath must be cautiously opened, a small hole being made in it as in the diagram (Fig. 497). It must be remembered that after the fascial sheath common to the artery and vein has been opened, there is still the proper sheath of the artery to be divided before the ligature can be safely passed The vein lies beneath the artery, and consequently the needle may be passed from the inner or outer side indifferently ; it should be passed unarmed, and then be threaded and withdrawn. Usually, no nerve is seen during the operation, but the internal saphenous occasionally comes into view, and must be avoided. After the operation a drainage-tube should be inserted in such a way that its end shall lie beneath the sartorius, and the wound is closed with sutures. The limb is then semi-flexed, somewhat raised, and laid on its outer side and wrapped in soft flannel or cotton wool. The severe pain which is usually complained of about the knee after tightening the ligature may be relieved by a full dose of opium.

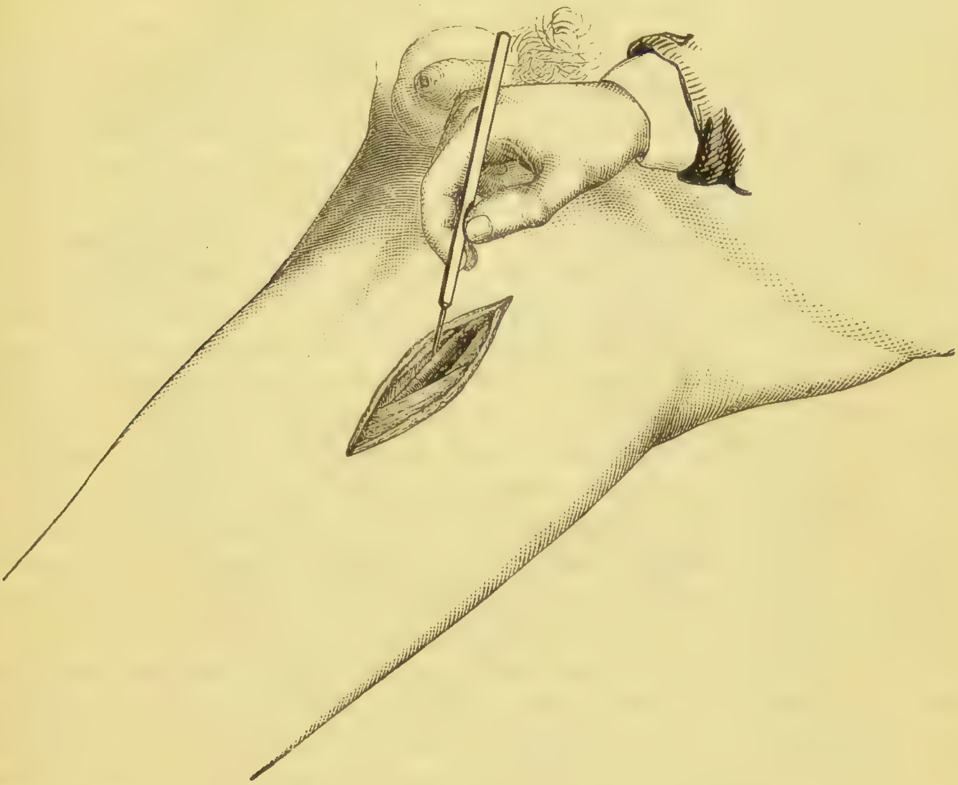


Fig. 496.—Ligature of the Superficial Femoral Artery.

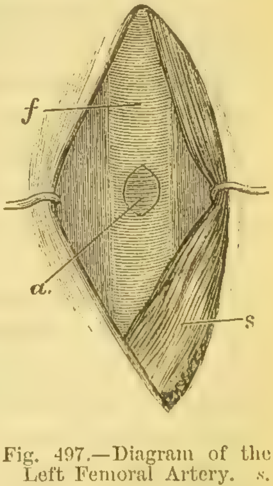


Fig. 497.—Diagram of the Left Femoral Artery. *s.* sartorius ; *f.* femoral sheath ; *a.* artery.

In this operation there are several points of considerable importance that require special attention : 1. The incision should be made directly in the guiding line of the artery. 2. In cutting down upon the artery, the saphenous vein should be avoided, by taking care not to make the incision too far inwards. Any parallel venous branch that may be met with must be drawn on one side. 3. After the sheath has been opened, it will sometimes be found that a rather large muscular branch is given off from the artery at about the part where it was intended to ligature it ; if so, this must be carefully avoided, as well as any small veins that cross the main trunk in this situation. 4. The ligature should not be applied less than four inches below Poupart's ligament, so that sufficient space may intervene between the origin of the deep femoral, which is usually from one or two inches below the crural arch, and the point deligated, to admit of the formation of a proper coagulum in the vessel. It has, however, happened that the ligature has been placed within three-quarters of an inch of the origin of the deep femoral, without any injurious consequences resulting. 5. The greatest care must be taken not to wound the femoral vein, which lies behind the artery in the situation in which a ligature is usually applied. If the vessel is tied a little higher than usual, the vein will be towards the inner side, and then the needle must be passed from within outwards. Wounding the vein is best avoided by properly cleaning the artery ; the white external coat must be thoroughly exposed, and while the needle is being passed the sheath should be put thoroughly on the stretch, the Surgeon holding the edge of the opening on the side from which he is passing the needle, while the assistant catches the opposite side in a pair of forceps and draws gently upon it. In passing the needle, its end should be kept very close to the artery, and made to circle round it. The vein is generally perforated by dipping the needle too deeply and losing the contact between it and the artery. When the needle is brought up on the outer side of the artery, a small portion of the sheath is sometimes pushed up by it ; this must be torn by pinching it with the forceps, when the needle may be carried round the vessel.

Results.—Ligature of the femoral artery for popliteal aneurism is an operation that has been so frequently performed, that Surgeons seldom think of recording cases of this description, unless they present complications or sequelæ of unusual interest or severity ; hence, but little importance can be attached to any statistical deductions from reported cases as to the fatality of this operation, although they may serve as a rough estimate of the proportion maintained between the different accidents, such as hæmorrhage, gangrene, &c., that follow it. That the ligature of the femoral artery is attended with more success than that of any of the other large trunks, can admit of no doubt. This is not only in accordance with the general experience of Surgeons, but is confirmed by the statistics of published cases, even without making allowance for the probability of more of the unsuccessful than of the successful having been recorded. Thus of 110 cases, collected by Crisp, in which the femoral artery had been ligatured for popliteal aneurism, only twelve are reported to have died ; amongst these, four deaths were caused by secondary hæmorrhage, three by gangrene, and the others by phlebitis, tetanus, chest-disease, &c. Higher rates of mortality are, however, given by other authors ; thus, Norris states that nearly one in four die after this operation ; Hutchinson finds that of thirty-three cases operated on in London, ten were fatal, five deaths resulting from gangrene. Holmes's statistics, which are extremely valuable as being collected directly from hospitals and not from published cases, show very favourable results. Of eighty-seven cases in which the operation was performed for femoral or popliteal aneurism, thirteen died, and in three the operation failed to cure the disease. Gangrene occurred twice, and suppuration of the sac not once. Of the deaths, one was from small-pox, two from wound of the vein and phlebitis, three from pyæmia, one from gangrene and amputation, one from disease of the kidneys, and the rest from various other causes. Barwell has collected also from hospital reports 67 cases occurring in the ten years 1870 to 1879 inclusive. Of these 10 died. Most of the deaths occurred, however, in the first half of this period, in which 32 cases were operated on, with 7 deaths and 2 amputations; while in the second half, out of 35 cases there were 3 deaths and no amputations. Barwell has also contrasted the results with reference to the various materials used as ligatures. He finds that in 14 cases silk was used; of these 3 died, 1 of rupture of an aneurism at the site of ligature, 1 of secondary hæmorrhage, and 1 of pyæmia, and in 1 case the aneurism relapsed. In 27 cases catgut was used; of these 6 died and 3 relapsed. Of the deaths, 1 arose from causes unconnected with the operation, 2 were due to secondary hæmorrhage, and 2 occurred after retying for relapse or aneurism at the site of ligature. In 4 cases the ox-aorta ligature was used successfully. The catgut used some years ago was somewhat uncertain in its quality, and in one of the cases in which secondary hæmorrhage occurred, it was applied without antiseptic precautions, and consequently differed but little from the old silk ligature in its properties. It remains to be determined what form of ligature gives the best results—whether catgut prepared according to the later methods (see Vol. I., p. 436), carbolized silk, or the ox-aorta, applied in such a way as not to divide the inner and middle coats. There is little doubt that the low death-rate of the later period is due to improvement in the ligature and in the after-treatment of the wound, and there is every reason to hope that it will at least be maintained, and probably be further reduced.

Accidents.—Wound of the Femoral Vein is without doubt the most serious accident that can happen in the operation for ligature of the superficial femoral artery, and is one of which there is especial risk when it is undertaken for aneurism, as the sheath of the vessels is often thickened and indurated by chronic inflammation extending upwards from the sac. The accident is best avoided by thoroughly exposing the external coat of the artery before attempting to use the needle, which, as already recommended, should be passed unarmed and without the employment of force. There are but few cases on record in which the patient has survived this accident, death usually resulting from septic phlebitis or from gangrene. The cause of the fatal result was first pointed out by Hadwen about thirty years ago. He showed that in wound of the vein the vessel is transfixed by the needle, so that when the thread is tied a segment of the wall is included with the artery in the noose, a portion of the ligature thus lying actually in the lumen of the vein. Upon the foreign body the blood necessarily coagulates, and a clot forms, obliterating the vein above and below the injured spot. In former times, when silk ligatures were used, the ends of which hung out of the wound, the thread always became more or less impregnated with decomposing matter, and thus septic changes were set up in the clot, leading to spreading phlebitis, disintegration of the clot and fatal septic embolism. Even if the patient escapes this danger, the simultaneous obliteration of the artery and vein almost invariably so far impedes the circulation as to cause gangrene. Guided by this view, the treatment becomes obvious. It consists in removing the ligature at once, and thus converting the wound into a simple puncture of the vessel, which readily heals. The Surgeon should, therefore, as soon as the accident is perceived, withdraw the ligature, and, opening the sheath about half-an-inch higher up, re-apply it to the artery there. The hæmorrhage from the punctured vein readily ceases on the application of a compress.

The occurrence of **Secondary Hæmorrhage** after the ligature of the superficial femoral is a troublesome accident, and one in which the Surgeon, to use Fergusson's expression, "will most assuredly find himself in an eventful dilemma;" and in which it is necessary that his line of action should have been well considered beforehand, as he may not have much time to spare for reflection when such an event takes place. In cases of this kind four lines of treatment present themselves, viz.: the employment of pressure; ligature of the vessel at a higher point; deligation of the bleeding artery in the wound; or amputation of the limb.

Pressure may be applied by placing a graduated compress of lint or compressed sponge over the bleeding orifice, and fixing it there firmly by a horseshoe tourniquet. This mode of treatment, although extremely uncertain, occasionally succeeds; should it not do so, however, and bleeding recur, it is useless to persist in it, as experience has shown that the hæmorrhage will continue until the patient is worn out.

Ligature of the superficial femoral at a higher point, or, if the artery have been tied too high for this, deligation of the common femoral or of the external iliac, presents itself as a probable means of arresting the hæmorrhage. Such an operation, however, is fraught with danger, and has, I believe, invariably been followed by gangrene. It might at first be supposed that the limb would not be placed in a worse situation after the ligature of the external iliac, whether the superficial femoral had been previously tied or not; the anastomosing channels remaining the same in either case. But in reality it is not so; for, although the blood might find its way through the epigastric, the circumflex iliac, the gluteal, and sciatic arteries, into the common femoral and the branches of the profunda, yet from this point the difficulty of its transmission through the limb would be materially increased. If the superficial femoral be open, it serves as a direct and easy channel for the conveyance, to the vessels of the leg and foot, of the blood brought by the anastomoses. But when the superficial femoral is tied, this blood must find its way through a second chain of anastomosing vessels,—those intervening between the branches of the deep femoral and the articular arteries of the knee; and here the real difficulty would arise, its impulse not being sufficient to overcome the obstruction to its passage through these small channels, which might not improbably be still further obstructed by the pressure of the aneurism. Should the anastomosing circulation be sufficiently free to maintain the vitality of the limb it is not improbable that the recurrent blood would escape from the distal side of the ligature, and thus keep up the hæmorrhage exactly as in case of wound. It appears indeed that the femoral artery, in a case of secondary hæmorrhage after the application of the ligature, is in very much the same condition as an artery which has been wounded, and in which the bleeding, having been suppresssed for some days, has returned with violence: and certainly the best course for the Surgeon to pursue is the same that he would follow in the event of secondary hæmorrhage occurring from a wounded vessel, viz., to *cut down upon the bleeding part and apply a ligature* to it. That such an operation is surrounded with difficulties cannot be doubted; yet none would present themselves that care and skill might not overcome. The Surgeon would certainly have to cut into a part infiltrated with blood, in which the different tissues could not readily be distinguished, and the vessel when reached would be found to be inflamed and softened; yet, by free dissection above and below the wound, a portion of it might at last be exposed, where its coats would hold a ligature; or should this not be found, the wound might be firmly plugged from the bottom with compressed sponge; or the bleeding aperture might be touched with the actual cautery. Should these means fail, it would be safer to *amputate the limb*, than to endeavour to arrest the hæmorrhage in any other way.

Gangrene of the Limb is perhaps the most frequent source of danger after ligature of the femoral artery for popliteal aneurism. It seldom occurs unless the tumour be of considerable magnitude, have become diffused, or otherwise interfere seriously with the circulation through the limb. I have, however, seen it follow the operation when the popliteal aneurism was not larger than an orange; but, in this case, there was much œdema and congestion of the limb before the operation; and, on examination afterwards, it was found that the popliteal vein had been obliterated by the pressure of the tumour. The gangrene may, in some cases, be prevented by the treatment that has been pointed out at p. 912 *et seq.*, Vol. I. When it has fairly declared itself, there is necessarily no resource left but amputation, and this operation is sufficiently successful; for I find that of fourteen cases in which it was done, there were ten recoveries, and but four deaths.

The **Return of Pulsation in the Sac** after the operation for popliteal aneurism is by no means of frequent occurrence: yet it has been met with in some instances, and **Secondary Aneurism** also has been found in this situation. In these cases the patient should be put upon a careful dietetic plan, the limb should be kept elevated and at rest, and direct pressure applied by means of a compress and bandage. In this way cures have been effected by Wishart, Turner, Briggs, and Liston. In conjunction with such treatment, or in the event of its not sufficing, the compression of the common femoral artery as it passes over the brim of the pelvis would in all probability effect a cure. Should it not do so, and the tumour continue to increase, threatening to suppurate, or to occasion gangrene, an attempt might be made to lay open the sac and to tie the artery above and below the opening, but should this fail amputation would be the sole resource.

If catgut be used, return of pulsation may be due to premature softening of the ligature. This is recognized by the presence of pulsation at the point at which the vessel was tied as well as in the sac. This is hardly likely to take place if well-prepared gut be used, and the wound be kept perfectly aseptic. Should it happen before the wound is healed, it may be opened up again and a second ligature applied above the situation of the first. If the coats appear to have been damaged by the first ligature, the vessel may be tied on each side of the injured spot and divided between the two ligatures. In some cases in which absorbable ligatures have been used, the recurrent pulsation has appeared at a much later period in consequence of a restoration of the lumen of the artery. Should this happen, the artery may be safely tied in Hunter's canal, as was successfully done by C. Heath under these circumstances.

Ligature of the Femoral Artery in the Middle of the Thigh (Hunter's Canal).—The point at which Hunter tied the artery in his earlier cases, was situated midway between the groin and the knee. At this point the artery lies in the angle formed by the vastus internus on the outer side, and the tendons of the adductor longus and adductor magnus behind. It is covered by a distinct fascia passing between these structures, forming with them the space known as Hunter's canal. The vein at this point lies to the outer side of the artery, and the long saphenous nerve enters the canal external to the vessels and crosses them superficially. The sartorius muscle covers the fascia closing in the canal. To tie the artery in this situation, the limb is placed in the same position as for the operation in Scarpa's triangle, and the same guiding line must be taken to find the course of the artery, but the incision must not be made in this line, but one finger's breadth internal to and parallel to it; otherwise the edge of the sartorius is easily missed. The incision must be from three to four inches in length, and its middle point must correspond to the middle of the thigh. The fascia lata is exposed, and opened, and the sartorius then comes into view. Its outer edge being found, it is pushed inwards, and held on one side with a copper spatula. The fascia closing the canal is then seen, and must be opened for about an inch and a half, thus exposing the sheath of the vessels (Fig. 498). If the saphenous nerve is seen, it must be drawn to one side with a blunt hook. The vein does not as a rule come into view, for as the limb is lying on its outer side it is beneath the artery and concealed by it. The sheath of the artery is then carefully opened and the needle passed from the outer side, the same precautions being taken as in the higher operation to avoid wounding the vein. The ligature should, if possible, be placed about one inch above the origin of the anastomotic branch. The errors that have to be guarded against in this operation, are, first, operating too low down. It must be remembered that Hunter's canal is situated midway between the groin and the knee. Secondly, if the wound be made too far out—in the guiding line of the artery instead of a finger's breadth internal to it—the outer border of the sartorius may be missed, and the vastus internus exposed instead. At this point there is usually an interval in the muscular fibres of the muscle that may be mistaken for the edge of the sartorius. The error is, as a rule, easily recognized by observing the direction of the muscular fibres, those of the vastus internus being directed downwards and outwards, while those of the sartorius are nearly vertical, slanting a little inwards. It is important that the fascia closing the canal should be opened freely, otherwise should pus form it may burrow along the artery into the ham.

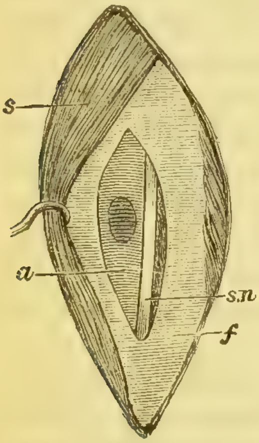


Fig. 498.—Diagram of Ligature of the Left Femoral Artery in Hunter's canal. *s.* sartorius drawn inwards; *f.* fascia closing the canal, opened freely: *a.* the artery, with a small opening in its sheath for the passage of the needle; *s.n.* long saphenous nerve.

The **External Iliac Artery** may require to be tied in cases of popliteal aneurism, when the superficial and common femorals are so diseased as not to admit ligature. This occurred once to me. A gentleman who had lost the left foot and leg from spontaneous gangrene, became two years afterwards the subject of a large popliteal aneurism in the other leg. As compression failed, it was decided to tie the superficial femoral. On cutting down on the vessel the coats were found so diseased, the artery itself being cylindrically dilated and slightly aneurismal, that the operation was abandoned ; and, as the common femoral felt dilated and almost incompressible from calcification of its coats, it was decided to tie the external iliac. This I did with the able assistance of Sir W. Fergusson, at a rather high point, the vessel being somewhat dilated and calcified lower down. Pulsation recurred in the tumour a few hours after the operation, the collateral circulation being very free, and the patient died of secondary hæmorrhage on the fifteenth day.

Double Popliteal Aneurism.—In cases of this kind the artery has been occasionally ligatured with advantage on both sides, either simultaneously, or, with more safety, consecutively. But these cases appear to me especially adapted for the employment of pressure, so as to avoid that disturbance of the balance of the circulation which is certain to ensue when one vessel is ligatured, and which may act injuriously upon the opposite aneurism. When the popliteal aneurism is conjoined with a similar disease in the groin, ligature of the external iliac is the proper course to pursue, and will effect a cure of both.

Diffused Popliteal Aneurism.—When a *circumscribed* popliteal aneurism suddenly becomes *diffused*, the patient is seized with faintness or sickness, with pain, numbness, and a hot trickling sensation in the limb, the temperature of which falls at the same time that its bulk increases, whilst the integument assumes, a white, shining, mottled appearance, with more or less purplish discoloration. After a time as the tension increases inflammation is set up, and the skin becomes red, hot, and œdematous, and the whole swelling may resemble in appearance a large abscess. Diffusion usually occurs after a circumscribed aneurism has existed in the ham for some weeks or months, and on the occurrence of some sudden exertion. In some cases, however, the disease appears to have been diffused from the very first, the coats having given way, and extravasation having taken place into the areolar tissue of the limb, without previous consolidation of the parts around the artery, or any attempt at the formation of a sac. In these cases the extravasation into the limb may either be conjoined with much œdema ; or it may be confined to the areolar tissue of the ham, and to the upper and back part of the leg, or may extend downwards under the muscles of the calf.. When the patient comes under the observation of the Surgeon, the tumour is found to be solid, elastic, and irregular, without pulsation or bruit ; the limb œdematous, cold, and congested. The diagnosis of this form of aneurism is often extremely difficult, and there is great danger of confounding it with simple extravasation into the calf, with abscess, or, possibly, with malignant tumour of the leg.

Treatment.—The danger attending on popliteal aneurism is greatly increased by its becoming diffused. In these circumstances the ligature of the artery usually affords but a slender prospect of success, the collateral vessels being so compressed and choked by the pressure of the effused blood as not to admit of the circulation being carried on through them ; hence the Surgeon has but two courses open to him, to lay the sac open, turn out the clots, and tie the vessel above and below the opening, or to amputate the limb.

The **Old Operation for Diffused Popliteal Aneurism** is undoubtedly a most difficult proceeding, owing to the depth at which the vessel lies and the position of the popliteal vein and the internal popliteal nerve superficial to the sac. In former times it was almost invariably followed by profuse and prolonged suppuration, and if the patient escaped the danger of secondary hæmorrhage, septicæmia and pyæmia, he recovered with a stiffened limb, often flexed to a considerable angle by the contraction of the scar in the ham. The operation was, therefore, at one time abandoned in favour of amputation. In the present day, with the help of Esmarch's bandage to render the limb bloodless, and antiseptic treatment, there is no reason why an attempt should not be made to turn out the clots and tie the vessel in every case in which gangrene has not actually set in, and in which the Hunterian operation is evidently inapplicable, but the Surgeon must be prepared to amputate immediately should he fail to secure the artery. In opening the sac the incision should be made in such a way as to avoid the vein. When the mouth of the sac is found, a full-sized bougie should be passed into it so as to distend the vessel, making it possible to clean it thoroughly before passing the needle.

Amputation for Diffused Popliteal Aneurism is the only resource left to the Surgeon should he fail to accomplish the old operation, or should gangrene have already declared itself. It is often difficult to determine what treatment to adopt in these most anxious cases. There are, however, certain general considerations that may guide the Surgeon in his decision.

1. In some cases, the sac has either given way to a very limited extent ; or else its walls, having become thin and expanded, are yielding rapidly under the pressure of the blood, becoming confused with the surrounding parts. Here we should ligature the artery without delay : for although it is but seldom that a limb can be saved when once the blood has become infiltrated into the general areolar tissue, yet it is possible that such a fortunate occurrence may happen.

2. In other instances the aneurism has not from the first been very distinctly circumscribed. It has followed the infliction of some mechanical injury, and in the course of a week or two has acquired a considerable size, without definite or distinct limitation, being solid or but little compressible. Such a case as this can scarcely be considered, strictly speaking, a diffused aneurism ; but yet, if by *circumscribed* we mean that the blood is contained in a cyst with defined walls, it scarcely complies with such a definition, the fluid blood being rather prevented from escaping widely by a temporary barrier of coagula entangled in the loose areolar tissue of the part, and the vessel being extensively ruptured or completely torn across. Here we are certainly justified in having recourse to compression or ligature, with a good prospect of success.

3. When the ham is occupied by a large rapidly increasing tumour, extending perhaps some way down the calf and up the thigh, and encroaching on the knee, the skin covering it being more or less discoloured, there being no pulsation perceptible in the tibial arteries, and the veins of the limb being full and even somewhat congested, the foot œdematous and several degrees cooler than the opposite limb, the difficulty of coming to a decision is considerable.

In such a case as this, I think that the existence or absence of distensile pulsation is a circumstance of very great importance, and may serve to guide the Surgeon. If there be distinct impulse of a distending character, which can be arrested by compression of the femoral artery, with some diminution of the size of the tumour, it is evident that blood is being transmitted through the sac, and that this contains some fluid blood. In these circumstances it will, when the artery is tied, subside to a considerable extent, thus allowing more space for the conveyance of the collateral circulation ; and it would be but right to give the patient the chance by ligaturing the vessel.

If, however, the tumour have, from the very first time when it attracted the patient's notice, been more or less solid and incompressible ; and, though it may at an early period have pulsated, if this pulsation have suddenly ceased, the aneurism at the same time having undergone rapid and great increase of bulk with much tension and lividity of the integuments, œdema and coldness of the limb, with a tendency perhaps to vesication and sloughing of the skin covering the tumour, an attempt may be made to perform the old operation, everything being prepared for immediate amputation in case of failure.

It must, however, be borne in mind, that the aneurism may become diffused, and extensively so, without any very great change in the shape and size of the limb. It is only when the sac ruptures in such a position that the blood escapes into the general areolar tissue of the limb or under the skin, that much tension of the integuments and increase in the bulk of the part take place.

4. When a rupture occurs in a part of the sac that is more deeply seated, the blood is extravasated underneath the deep fascia of the leg, and is bound down by this ; and disorganization of the interior of the limb may be the result, without much change in its bulk or in the colour of the integuments, but with excessive deeply seated pain. There must always be considerable risk, in such a case as this, of confounding the arterial disease with a solid tumour ; and the diagnosis can be effected only by reference to the early history of the case, and more particularly to the existence or absence of pulsation at this period. Indeed, the existence or absence of pulsation in these cases is of the utmost importance in reference to the question of treatment. The pulsation may have ceased in a case of diffused popliteal aneurism, in consequence of the blood that has been extravasated being so confined and bound down by the fascia and muscles under which it is effused, that it compresses the mouth of the artery leading into the sac, to such an extent as to arrest the passage of blood through it, either wholly or so that it enters in a feeble stream of insufficient force to communicate an impulse to the fluid that has been extravasated into the limb. This pressure may, as in the case of which an illustration has been given (Fig. 451), be confined to the deep parts of the limb, and not give rise to much, if any, general tension of it, the blood being confined below the deep fascia, where it communicates the sensation of a hard, solid, elastic tumour devoid of pulsation. Attention should consequently not be too exclusively directed to the state of general tension of the surface of a limb, as this is by no means necessarily an indication of the state of the parts beneath ; but the Surgeon should look rather to the presence or absence of pulsation. If pulsation still exist, the blood continues to find its way into the sac, and most probably through it, the tension of the parts not having yet reached its maximum. If there be no pulsation, he may be sure that the entrance of blood into the diffused aneurism has ceased in consequence of compression exercised on the mouth of the artery leading to it, by the tense condition of the surrounding tissues re-acting on the mass of blood effused beneath them. In such a state of things as this, the vitality of the lower part of the limb can be maintained only by the blood that may find its way through the anastomosing channels ; and this may be sufficient for the purpose if the

tension of the limb be not general, the extravasation being confined below the deep fascia. If surgical interference be delayed in such a case as this, the deep fascia will soon give way by over-distension and rupture, and the blood will be infiltrated into the general areolar tissue of the limb ; and then, by compressing those collateral branches that have hitherto maintained a feeble circulation in it, will infallibly occasion gangrene. If, on the other hand, recourse be had to ligature of the main artery, the anastomosing circulation, which may have been barely sufficient to keep up a feeble vitality in the leg and foot, will be so much interfered with that gangrene of the limb inevitably ensues. In these cases an attempt may be made to save the limb by laying open the sac and ligaturing above and below its mouth. Should it be impossible to accomplish this the only resource that is left is to amputate at once.

5. When gangrene threatens, the leg and foot having become cold, the skin being either pale, tallowy, and mottled, or discoloured, of a purplish hue, with perhaps vesications and much œdema, whether the ligature have been previously applied to the femoral artery or not, or whatever the condition of the aneurism may be, whether circumscribed or diffused, the patient will stand a better chance of ultimate recovery by having the limb removed at once above the knee. The part at which amputation should be performed in these cases is a point deserving consideration. If the femoral artery have been ligatured, the thigh should be amputated on a level with the ligature, the artery being cut just above this. In this way the double risk which the patient would otherwise run of secondary hæmorrhage from the seat of the ligature, as well as from the face of the stump, will be reduced to a single chance of hæmorrhage from the stump. If the amputation be the primary operation, it should be done at the lower third of the thigh, provided the extravasation be confined to below the knee ; or higher up, if the effused blood have extended above this joint.

Aneurisms of the Tibial Arteries are extremely rare, except as the result of wound, yet they are occasionally met with ; and in the museum of St. George's Hospital there is a preparation of a small aneurism of the posterior tibial. I have seen only one case during life, that of a man suffering from cardiac and renal disease, admitted into University College Hospital under my care for an aneurism of the anterior tibial at the lower part of the upper third of the right leg. The signs were well marked—pulsation forcible and excentric, bruit loud. Compression was used without avail ; and as he was anasarcous, no other surgical treatment could be adopted. He left the hospital uncured.

The popliteal and tibial arteries sometimes require ligature for injury, but very rarely for disease. The operations may be briefly described here.

Ligature of the Popliteal Artery.—The popliteal artery may be tied at any part of its course. In *the lower two thirds* it can be reached only by an incision in the line of the vessel. The external saphenous vein will be found in the subcutaneous tissue, and must be avoided. After dividing the fascia lata the internal popliteal nerve must be found and drawn to the outer side. The vein then comes into view and must be drawn out of the way, when the artery will be exposed lying deeply on the posterior ligament of the knee-joint. This operation is never undertaken except for a wound, and consequently must always be more or less of an informal character. In *its upper third* the vessel is reached most easily from the inner side. The guiding line for the incision is the posterior border of the tendon of the adductor magnus. The knee is flexed and the limb placed on its outer side, and an incision is made from three to four inches in length parallel to the tendon of the adductor magnus and immediately behind it. Its upper extremity should correspond to the junction of the lower and middle thirds of the thigh. The skin and superficial fascia are divided, avoiding the long saphenous nerve if possible, and the deep fascia opened. The edge of the tendon of the adductor magnus, which forms the first rallying point in the operation, is then sought for. Some branches of the anastomotica magna are divided at this stage of the operation and require ligature. When the adductor tendon is found, the sartorius and gracilis and inner hamstring muscles are pushed backwards with the finger and held with a copper spatula. Care must be taken not to pass the spatula between the bone and the artery, which is surrounded in this situation by a considerable amount of loose fat. This fat being torn through, the artery is exposed without much difficulty. The vein and the internal popliteal nerve lie to the outer side and are not seen. The ligature should not be applied too near the superior articular branches.

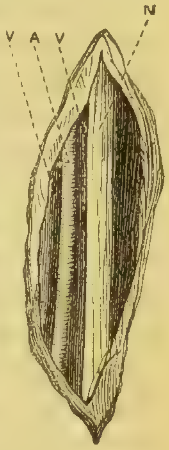


Fig. 499.—Diagram of Right Posterior Tibial Artery, behind Inner Malleolus. A. Posterior Tibial Artery. V. V. Venæ comites. N. Posterior Tibial Nerve.

Ligature of the Posterior Tibial Artery.—The line of direction of the posterior tibial artery is from a point about one inch below the knee, and equidistant from the two sides of the limb, to a point one finger's breadth behind the inner malleolus. The vessel may be tied at any part of its course, but it has rarely been undertaken as a formal operation except about the middle of the calf or behind the inner malleolus.

In *the middle of the leg* the posterior tibial artery should be tied only for a wound, and in such circumstances, as a rule, no regular operation can be performed; but an incision of sufficient length, taking the wound for its centre, should be made through the gastrocnemius and soleus parallel to their fibres, when, after these have been cut through, the deep fascia will be exposed. This must next be opened, when the artery will be found accompanied by its veins, and having the nerve to the outer side. From the depth at which the vessel is situated, and the free incisions that it is necessary to make through muscular parts, it is extremely difficult to apply the ligature in this situation. The later steps of the operation may be much facilitated by flexing the leg on the thigh, and extending the foot, so as to relax the muscles.

The regular operation as performed on the dead body is rarely required on the living. It is thus carried out. The limb is flexed and laid on its outer side. An incision is made four inches in length parallel to the posterior border of the tibia and about one inch behind it. The internal saphenous vein must be avoided if its situation can be ascertained. On dividing the deep fascia the edge of the gastrocnemius, if it has not fallen away to the outer side in the position of the leg, will come into view and is to be pushed to one side, exposing the surface of the soleus. This is next to be divided, the edge of the knife being now turned towards the posterior surface of the tibia. After cutting through about half an inch of muscular tissue a tendinous layer is exposed. This is the tendon of the deep surface of the soleus, and forms the first important rallying point in the operation. The tendon having been exposed in the whole length of the wound, it is picked up in the middle with a pair of forceps and carefully opened. The operator must now look to see if muscular fibres arise from its under surface. As a rule, no fibres arise from the internal half inch of the deep surface of the tendon, and if the incision through it be made at this point, the space between the deep and superficial muscles in which the artery lies is immediately opened. If the incision be more external, the fibres arising from the deep surface of the tendon must be divided before the proper space is opened, As soon as this is reached, the outer part of the soleus and the gastrocnemius must be drawn well outwards with a copper spatula, and the artery comes into view with a vein on each side, and the nerve most commonly to the outer side. The vessels are covered by a thin fascia and lie on the fascia covering the deep muscles. Care must be taken in dividing the soleus not to wound the latter fascia, as, should this happen, the artery is easily lifted with the superficial muscles. The needle should be passed from the side on which the nerve lies.

The *posterior tibial artery behind the malleolus* is reached by making a semilunar incision about two inches in length, curving round the posterior and lower part of the malleolus, and one finger's breadth behind it. After dividing the skin and fat, the internal annular ligament comes into view. If the guiding line have been accurately adhered to, the artery will appear immediately the annular ligament is divided. It has a thick-walled vein on either side of it, which may be mistaken for the artery in a bloodless limb, unless it be carefully examined. The nerve lies behind and external to the artery, and the needle must be passed from behind. The most common error in tying this artery arises from keeping to the convex instead of to the concave side of the wound while deepening the incision. The deep parts of the incision thus gradually approach the malleolus, and the tendons are reached instead of the artery. The tendon of the tibialis posticus is that exposed, as it is most superficial. The artery must then be looked for behind this, and *immediately beneath the annular ligament.* If the dissection be carried on past the sheath of the tibialis posticus till the flexor longus digitorum comes into view, it will pass beneath the artery, which is usually then held out of the way in the posterior blunt hook, and is thus missed. The flexor longus pollicis lies so far behind the artery that it is scarcely possible to expose it.

The **Anterior Tibial Artery** may be tied in several situations ; but, like the posterior tibial, it should not be ligatured in the upper or middle parts of the leg, except for injury. The difficulties of the operation are lessened as the ankle where the artery becomes superficial, is approached. The line of direction of the anterior tibial artery is from the inner side of the head of the fibula to a point exactly midway between the two malleoli ; and the course of the dorsal artery of the foot is from this point to the cleft between the first two toes.

In the upper third of the leg the artery lies deeply between the tibialis anticus and extensor communis digitorum, surrounded by veins and having its nerve to the outer side. If it ever be found necessary to tie it in this situation, an incision should be made in the guiding line of the artery, from four to five inches in length. The deep fascia must be opened, and, if necessary, notched transversely. In the upper fourth of the limb the tibialis anticus arises from the fascia, which adds somewhat to the difficulty of finding the interval between the muscles. The first intermuscular space to the outside of the tibia is the one to be sought for. When it is found the ankle must be flexed to relax the muscles, which are then held apart with copper spatulæ. The artery may then be cleaned with a director, and the needle passed obliquely beneath it. In operating high up in the limb it is possible to slip into the space between the peronei and the extensor digitorum. This error is at once recognized by finding a distinct fibrous intermuscular septum, no such structure existing between the tibialis anticus and the flexor digitorum.

In the middle and lower thirds of the leg the artery will be found between the tibialis anticus and the extensor proprius pollicis; the latter muscle does not, however, reach the surface above the middle of the leg. The right space is found by keeping accurately to the guiding line of the artery, and, after the fascia is opened, taking the outer border of the tibialis anticus as the guide. The edge of the flexor longus digitorum is recognized by its rounded tendon, reaching considerably above the middle of the leg, with fleshy fibres joining it on the outer side.

The **Arteria Dorsalis Pedis** runs from a point midway between the two malleoli to the base of the space between the first and second metatarsal bones, and may be felt pulsating in this line. It lies external to the tendon of the extensor proprius pollicis, and is crossed near its lower end by the internal belly and tendon of the extensor brevis digitorum. It is sometimes absent, and not unfrequently lies external to the line just mentioned. It is reached by an incision in the line of the artery, one inch and a half in length, the lower end of which corresponds to the base of the space between the first two metatarsal bones. The superficial and deep fascia being divided, the artery may immediately come into view. If it does not, the inner belly and tendon of the extensor brevis must be sought for, and its inner border followed till the long extensor is reached. If the artery is not seen passing beneath the tendon of the short extensor, that muscle must be forcibly pulled outwards and the vessel sought for beneath it. If it does not then come into view, it is probably absent. The termination of the anterior tibial nerve accompanies the artery when it is in its normal situation, and lies usually to the outer side.

The **Peroneal Artery** has been tied in rare cases for wound in the middle of the leg. It is found by making an incision about three inches in length on the posterior border of the fibula, which is the first "rallying point" in the operation. A thin tendinous layer, forming part of the origin of the soleus, and sometimes a few fleshy fibres, are found attached to the bone. On dividing these, the flexor longus pollicis comes into view. This is cut carefully away from the posterior surface of the bone, and at its inner edge a tube of fascia is found, in which the artery lies between the flexor pollicis and tibialis posticus. This must be opened, and the venæ comites separated with a director, after which the needle is easily passed.

DISEASES OF THE ORGANS OF SUPPORT AND MOTION.

CHAPTER XLVI.

INFLAMMATION OF BONE AND ITS EFFECTS.

GENERAL PATHOLOGY OF INFLAMMATORY AFFECTIONS OF BONE.

Before considering the diseases of bone as they present themselves to the practical Surgeon, it will be convenient to describe the different pathological effects of inflammation on the separate structures of which a bone is composed, viz., the periosteum, the medulla and the osseous tissue. The necessity for this arises from the fact that inflammatory affections are rarely limited to one of these structures. Thus inflammation commencing in the periosteum, if it last for any length of time, always produces more or less marked changes in the compact tissue beneath, and the cancellous tissue is never affected without the periosteum sooner or later taking part in the morbid process. I propose, therefore, to describe briefly the various effects of inflammation as they manifest themselves in the different structures of which a bone is composed, attaching as far as possible a definite name to each by which it can be referred to in the clinical description of the diseases as they occur in practice.

The process of inflammation in bone is essentially the same as in all other tissues—such modifications as exist being due solely to the structure of the affected part. In the Chapter on Inflammation it was pointed out that in the more acute or destructive processes of inflammation the inflamed tissue becomes infiltrated with new cells, before which the original structures disappear. In the soft parts of a bone, the medulla and periosteum, this takes place exactly as in other tissues, but in compact bone the process is restricted and delayed by the density of the structure. The new tissue undergoes the same changes in bone as elsewhere, it may soften and break down into pus, it may suffer from fatty degeneration and caseation, or it may develop, the product being as a rule osseous, instead of fibrous tissue, as in the soft parts. The chronic productive inflammatory processes which in the soft parts lead to fibroid induration or overgrowth of the connective tissue, when affecting a bone lead to the formation of new osseous tissue, but the process is essentially the same. As in other parts the inflammation may end in death of the affected tissue. Acute infective inflammations are also met with, and the chronic processes associated with the presence of tubercle are common. All these inflammations are identical in character with those already described as affecting the soft parts, such differences in detail as exist being due solely to the physical peculiarities of the tissue implicated.

Inflammatory Processes in the Periosteum.—The periosteum is composed of two layers, the more superficicial of which consists chiefly of white fibrous tissue ; the deeper contains a large proportion of yellow elastic tissue. Forming part of the deep layer in immediate contact with the bone is a stratum which contains numerous cells. In growing bone these have the ordinary appearance of the cells always found immediately preceding the formation of new bone, the so-called osteoblasts ; they are granular and somewhat angular in outline. In adult bone these are represented by flattened cells, but they readily resume the form of osteoblasts under slight degrees of stimulation. The periosteum is extremely vascular, the vessels breaking up in it and entering the Haversian canals of the bone beneath, and numerous nerves may be traced in its structure. The effects of this structure in modifying the process of inflammation are obvious. The extreme vascularity of the membrane favours exudation, and the inflammatory products accumulate most abundantly in the deeper layers, and between them and the bone, beneath the denser fibrous layer. They penetrate also along the vessels into the Haversian canals. Owing to the abundant nervous supply and to the tension caused by the unyielding nature of the superficial layers of the periosteum, inflammatory exudation is often accompanied by very severe pain. Should the inflammation terminate in suppuration the vessels passing from the periosteum to the bone are destroyed, and death of a portion of the compact tissue may result. This is, however, by no means a necessary consequence, especially if the periosteum be separated only to a small extent, as the blood-supply from the medulla is sufficient to maintain the vitality of the denuded bone. Sloughing of the periosteum as a result of inflammation is a somewhat rare occurrence owing to the abundant vascularity of that structure. Caseation of the inflammatory products is not common in periostitis, but is occasionally met with. Lastly, new bone is formed with great readiness in all chronic inflammatory processes in the periosteum, the mode in which it is developed being the same as in physiological growth, though wanting in regularity. The following are the names given to the various inflammatory processes occurring in the periosteum :—(1.) Simple Acute Periostitis ; (2.) Suppurative Periostitis, *a.* Simple and Localized : *b.* Infective and Diffuse ; (3.) Chronic Osteoplastic Periostitis ; (4.) Chronic Suppurative Periostitis ; (5.) Syphilitic Periostitis.

1. **Simple Acute Periostitis.**—This is most commonly the result of injury. The membrane is redder and thicker than natural. It separates easily, and as it is stripped off fine threads are seen passing from it into the bone ; these are the vessels which are loosened by the exudation into the Haversian canals, and consequently draw out more readily. On section the swollen membrane presents a somewhat gelatinous appearance, due to the infiltration of its structure with the inflammatory exudation ; this is most marked in the deeper layers next the bone. Microscopic examination shows only the ordinary appearances of inflammation—dilatation and fulness of the vessels and numerous small round cells infiltrating the fibrous tissue, especially its deeper layers. Simple acute periostitis may end in resolution with a perfect return to the normal condition, or it may pass on to suppuration, but more commonly it becomes chronic and assumes the osteoplastic form.

Suppurative Periostitis, (*a*) **Simple Acute Periostitis,** resulting from injury occasionally terminates in suppuration. The pus forms between the membrane and the bone, and slowly perforates the fibrous layer. It shows but little tendency to extend beneath the periosteum or to separate it widely from the bone. It may be followed by death of the exposed portion of the compact tissue, but, as before stated, this is by no means necessary.

(*b*) **Infective Inflammation of the Periosteum** is a much more serious affection. It occurs chiefly, if not exclusively, in young subjects. It terminates very early in suppuration and the pus diffuses itself widely, stripping the periosteum from the bone, sometimes throughout the whole extent of the diaphysis. When it reaches the epiphyses the inflammation and suppuration extend in the growing tissue between them and the shaft, and thus in extreme cases the whole diaphysis may lie loose in the cavity of a vast abscess enclosed within the undestroyed fibrous layer of the periosteum ; finally, this is perforated, and the pus diffuses itself amongst the surrounding tissues. In spite of the acuteness of the process, the periosteum very rarely sloughs, and if exit be given to the pus the intensity of the inflammation subsides and the periostitis assumes the osteoplastic form, new bone being abundantly deposited beneath it. Infective periostitis almost invariably leads to death of a considerable portion of the bone which has been laid bare by the separation of the membrane, but the extent that perishes does not necessarily correspond to that separated from its periosteum.

Osteoplastic Periostitis.—This is essentially a chronic process. It occurs as a consequence of the slighter forms of irritation, or as a sequel of acute inflammation. It is very frequently met with also as an accompaniment of more deeply seated inflammatory mischief, as of the medulla or cancellous tissue, and in the neighbourhood of diseased joints. In young subjects it results from very slight sources of irritation, being then merely an exaggeration of the normal process of growth. In osteoplastic periostitis the membrane is thickened and more vascular than natural. It separates with some ease, and its under surface often feels gritty from small fragments of new bone that have come away with it. Beneath it and adherent to the compact tissue is the new bone formed as the result of the process. This may be arranged in smooth layers, parallel to the surface of the bone, in nodules or in pointed processes. When the nodulated or spiculated masses reach any considerable size they are frequently termed *osteophytes*. The new bone formed in the early stages of osteoplastic periostitis is soft and spongy, being traversed by large canals containing vessels surrounded by large cells. These canals are set at right angles to the surface of the bone. As recovery takes place the new bone is partly absorbed, the irregular nodular or spiculated masses are smoothed down and the remainder gradually increases in density, till it becomes indistinguishable from the compact bone beneath.

Microscopic examination of the parts involved in osteoplastic periostitis shows that the swollen membrane is infiltrated with small round cells, proportional in number to the acuteness of the process. In the deeper layers in contact with the newly-forming bone, the cells assume the characteristic angular shape and granular appearance of osteoblasts. There seems to be a direct transition from the granulation-cells infiltrating the inflamed membrane to the osteoblasts, and it has therefore been supposed that they are developed from migrating cells, but, as in the case of productive inflammatory processes elsewhere, it seems probable that the original cells of the deeper layer of the periosteum also takes part in the formation of the new tissue after the acute stage has subsided. The new bone is formed subsequently in the same way as in normal ossification. A homogeneous ground-substance is developed between the osteoblasts which soon becomes indistinctly fibrillated and subsequently calcified. Some of the osteoblasts seem to disappear, while others remain, forming the bone-corpuscles. The development of the inflammatory new growth into bone commences at the points most distant from the vessels, and gradually encroaches on them till they come to lie in channels surrounded by bone (Haversian canals). We have before seen that the same changes occur in the formation of callus in the repair of a fracture (Vol. I., p. 526), but in these circumstances cartilage occasionally appears before the development of bone. This is never met with in osteoplastic periostitis arising from other causes.

Billroth is of opinion that the new bone developed in osteoplastic periostitis is not always formed solely from the periosteum. That it is so in those cases in which the compact tissue beneath is dead is of course evident, but in other cases he believes that granulation-tissue sprouting out of the openings of the Haversian canals takes part in the process. In the union of fractures the callus is partly formed from the injured soft parts superficial to the periosteum.

Chronic Suppurative Periostitis is not common, but occasionally the periosteum is found separated from the bone by a small quantity of curdy pus such as is met with in chronic abscesses elsewhere. It is usually merely a secondary process, being dependent on some of the destructive changes to be subsequently described as commencing in the bone beneath.

Syphilitic Periostitis and Gummata of the Periosteum have already been described (Vol. I., p. 1150).

Any localized chronic inflammatory swelling of the periosteum, whether simple or syphilitic, and whether accompanied by the formation of new bone or not, is commonly termed a *node*.

INFLAMMATORY PROCESSES AFFECTING THE COMPACT TISSUE OF A BONE.—The compact tissue of bone is composed of lamellæ arranged for the most part concentrically around the Haversian canals. Beneath the periosteum the lamellæ lose their concentric arrangement and lie parallel to the surface. Between the lamellæ lie the bone-corpuscles in the lacunæ and from these the fine canaliculi pass through the bony tissue. The Haversian canals are narrowest near the surface, and gradually increase in size towards the deeper parts, so that the compact and the cancellous tissue gradually merge into each other without any sharp line of distinction between them. Each Haversian canal, except the very smallest, contains a small artery and vein, a flattened lymphatic vessel, and a pale nerve-fibre, surrounded by a small amount of delicate connective tissue containing branched cells. There is no reason to believe that the bone-corpuscles take any active part in the inflammatory processes in bone; all the changes observed proceed from the Haversian canals. The nature of the tissue in which the inflammation is taking place necessarily causes some modification in the phenomena. Exudation and migration of the corpuscles occur as in other structures, but the amount is somewhat limited by the unyielding nature of the surrounding tissue. The swelling of the delicate connective tissue in the Haversian canals will moreover tend to compress the vessels, and thus in acute inflammation of compact bone death of the affected part is very prone to occur from arrest of the flow of blood through it. Should this not happen, we see the same changes occurring as in other tissues; the new cells increase in number and the original tissue disappears before them. In bone this process is necessarily slow on account of the density of the structure, but ultimately a portion of the solid bone may be as completely destroyed before the advancing cells as are the soft tissues in the formation of an abscess-cavity, or in ulceration of the skin. When recovery takes place the inflammatory products develop into bone instead of into fibrous tissue as in the soft parts. The compact tissue is liable also to chronic inflammatory affections of the same type as those leading to fibroid induration of the soft parts, but in bone the product of the process is new osseous tissue which develops in the Haversian canals, gradually narrowing them, and rendering the texture more dense than natural.

The inflammatary processes observed in compact bone are the following:—(1.) Rarefying or rarefactive osteitis; (2.) Osteoplastic or condensing osteitis; and (3) Necrosis.

Rarefying or Rarefactive Osteitis.—This may occur as a secondary effect of inflammation commencing in the periosteum or in the medulla. It is observed also as the result of injury, as in a piece of bone denuded of its periosteum, or on each side of a fracture. In many cases its original cause is very obscure.

A portion of compact bone undergoing this change is in the earliest stages observed to be slightly redder than natural; the openings of the Haversian canals after a time become somewhat increased in size, and consequently a larger number are visible to the naked eye. As the process advances the Haversian canals increase at the expense of the solid bone surrounding them, and when they reach a sufficient size they can be seen to contain a small quantity of pink granulation-tissue surrounding the vessel. If a portion of the bone at this stage be macerated it presents a porous spongy appearance, almost resembling cancellous tissue. If the process advances still further, as in the separation of a piece of dead bone, the neighbouring enlarged Haversian canals coalesce, the solid osseous tissue disappearing entirely, and a soft mass of granulation-tissue fills the space once occupied by solid bone. The superficial layers of the granulation-tissue may break down into pus under the same conditions that give rise to suppuration elsewhere, or, should the process cease, the new tissue develops into bone by the same process as in osteoplastic periostitis, the new osseous tissue being first formed in connection with the old.

The rarefying osteitis may be limited to a small portion of the bone as in the separation of a sequestrum, or may be diffused over a wide area. In the latter case it is more chronic, and, although rendering the bone more porous than natural, rarely leads to its complete destruction for any great extent.

Microscopic examination of a piece of bone affected by rarefying osteitis shows the following appearances. In the earliest stage the vessels are distended with blood, and numerous cells, probably migrated leucocytes, are found in the delicate connective tissue contained in the Haversian canal. In a more advanced stage these cells are greatly increased in number, and the wall of the canal is seen to have been consumed away before them. The destruction of the osseous tissue takes place irregularly in excavated crescentic hollows, first described by Howship, and consequently named "*Howship's lacunæ.*"

A large number of these will be found to be filled by cells of considerable size containing several nuclei, each cell corresponding to a lacuna. These many-nucleated cells are found wherever bone is being destroyed, whether from inflammation or in a physiological process, as the development of the medullary canal, and they are supposed to play some important part in the absorption of the osseous tissue. For this reason they have received the name of *osteoclasts.* They lie directly in contact with the bone, the rest of the space surrounding the vessels being filled with the ordinary small round cells of granulation-tissue. Their mode of development and subsequent fate are uncertain. The osseous tissue which is yet undestroyed often presents no evident change. The bone-corpuscles certainly show no signs of taking any part in the process. Should they show any change it is one of degeneration, not of proliferation. They may be unnaturally granular, and are sometimes represented merely by an oil-globule, or a mass of fat-granules. They can in most cases be seen to be unaltered until the lacunæ in which they lie are opened by the advancing absorption of the osseous tissue, and after that their fate is unknown.

When the destructive process has advanced far enough to form a considerable space filled with granulation-cells around the original vessel of the Haversian canal, new capillary loops are formed penetrating amongst the new tissue, just as in the development of granulation-tissue in a wound.

The destruction of bone by the pressure of a tumour or an aneurism, or its infiltration by a malignant growth, is carried out by the same process as that just described, but in the former case, when the Haversian canals have become sufficiently enlarged, the special elements of the tumour penetrate into them, displacing the granulation-tissue. The compact tissue may in like manner be invaded by the specific tissue of a syphilitic gumma.

Various terms are applied clinically to this rarefying osteitis under its different modifications. When the process is widely diffused, a large part of the shaft of a bone being rendered more porous than natural without complete destruction of the osseous tissue, it is sometimes termed *inflammatory osteoporosis.* When only a localized area is affected, as in the separation of dead from living bone, with complete destruction of the osseous tissue, and subsequent formation of pus from the granulation-tissue replacing it, it is termed *simple ulceration of bone.* When it occurs as the result of the infiltration of the compact tissue by a sub-periosteal gumma followed by softening and suppuration of the new growth, it is described as *syphilitic caries.*

Osteoplastic Osteitis or **Osteo-sclerosis.**—This is always an extremely chronic process. It may occur as a sequence of diffuse rarefactive osteitis, or as the secondary result of some central mischief occurring in the cancellous tissue or medulla, or as a consequence of syphilis. Osteoplastic osteitis is characterized by a development of new bone in the connective tissue surrounding the vessels in the Haversian canals. The mode of formation of the osseous tissue is the same as in osteoplastic periostitis. As the result of the process the bone becomes greatly increased in density, frequently with complete obliteration of many of the Haversian canals. This may even go on to such an extent as to cut off the vascular supply from a portion of bone and thus cause its death. The bone may assume the consistence of ivory. At the same time it may increase in thickness, partly from a simultaneous growth of bone from the periosteum, and partly apparently from interstitial growth in the bone itself. The new bone, though denser in structure, resembles healthy osseous tissue when examined by the microscope.

The two processes just described, osteoplastic and rarefactive osteitis, not unfrequently go on side by side, giving rise to the appearance known as **expansion of bone.** The compact tissue, when thus affected, becomes more spongy than natural, and the arrangement of its structure is often more or less completely altered. In normal compact tissue some of the superficial lamellæ lie parallel to the surface, but in the greater part they are arranged circularly around the Haversian canals ; not unfrequently, however, we find in chronic osteitis that the compact structure undergoes a peculiar laminated expansion, so that a section of it presents throughout parallel layers, concentric with the medulla. The lamellæ are separated from each other by pink vascular tissue. This change is necessarily accompanied by considerable increase in size of the affected bone, which may extend throughout a great part of its length. Microscopic examination shows, in such a case as this, that the pink tissue between the bony laminæ is composed chiefly of round cells, like those of ordinary granulation-tissue, but on one side of the lamella the cells in contact with the osseous layer are assuming the form of osteoblasts, indicating that formation of bone is taking place ; while, on the other, the surface of the lamella is irregular, presenting the hollows known as Howship's lacunæ, and in these are the large many-nucleated cells, or osteoclasts, which are indicative of destruction of bone. This process, when occurring as a pathological change, is usually regarded as inflammatory, but the close analogy between it and normal growth is evident. In the growing bone of a child the medullary canal is hollowed out by a process similar to that just described, and new bone is constantly deposited on the surface by the periosteum. In chronic osteitis with "expansion" of the bone, the chief difference is in the diffusion of the process throughout the compact tissue and its irregularity. If the source of irritation to which the expanding osteitis is due be removed, the destructive part of the change ceases and new bone is formed on both sides of the lamellæ, and thus, while the abnormal size is more or less completely retained, the structure becomes as dense as, or sometimes denser than, normal compact tissue.

In some few cases the appearances presented by the diseased bone are such as to suggest that the periosteum takes but little part in the process, but more commonly expansion of the compact tissue is associated with laminated deposits of new bone from the periosteum.

Expansion of bone by a tumour is a change of the same character, the destructive processes just described taking place in the parts pressed on by the growth while at the same time new bone is developed beneath the periosteum. Thus, even when the tumour greatly exceeds the normal bone in size, it is often found to be still surrounded by a shell of osseous tissue.

Syphilitic Osteitis has been already described (Vol. I., p. 1151).

Necrosis of the Compact Tissue may be the result of direct injury, as a severe blow. A portion of bone may perish from its vascular supply being cut off by separation of the periosteum by injury or by the formation of pus beneath the membrane ; and in like manner suppuration in the medullary canal may cause the death of neighbouring compact tissue. When the compact tissue becomes involved in acute inflammation extending to it, either from the medulla or from the periosteum, it is very apt to necrose from pressure upon the vessels in the Haversian canals by the inflammatory exudation within them. Chronic osteoplastic osteitis may also, in some cases, end in necrosis from gradual obliteration of the Haversian canals. It is quite possible that small fragments of bone may die and be subsequently absorbed; but that this may take place it is necessary that the dead portion must be of small size and free from irritating properties. If it have perished in consequence of some infective inflammation, or have been impregnated with decomposing matter, its absorption becomes impossible, for absorption of bone is carried out solely by the medium of the living cells before described, and these cannot exist in a healthy state in the presence of the virus of an infective process or the products of putrefaction. Larger fragments of dead bone are always separated from the living and cast off. This is accomplished entirely at the expense of the living bone. The process by which it is carried out is merely one of rarefying osteitis carried to its highest stage, and ending in complete destruction of the osseous tissue where the living is in contact with the dead, its place being occupied by granulation-tissue. The layers of this tissue touching the dead bone break down into pus, and thus complete separation is accomplished. The further details of the process will be given when treating of necrosis clinically.

INFLAMMATORY PROCESSES IN THE MEDULLA OF LONG BONES.—The marrow of a long bone is composed of fat, supported by a delicate connective tissue and traversed by vessels. It contains numerous cells resembling white corpuscles. In contact with the solid bone the connective tissue assumes an imperfect membranous form and is more abundantly vascular, and this layer has received the name of the medullary membrane. It is unnecessary to enter into any great detail in describing the inflammatory processes that occur in the marrow of bone, as they are the same as in other soft structures. The forms of inflammation occurring in the medulla are the following:—(1) Simple osteomyelitis; (*a*) acute, (*b*) chronic. (2) Diffuse acute osteomyelitis; (*a*) septic, (*b*) infective.

1. **Simple Acute Osteomyelitis** is usually of traumatic origin. The phenomena observed are the same as in other soft parts, dilatation of the vessels, exudation and migration of the corpuscles, and gradual disappearance of the normal tissues before the new cells. In compound fractures and amputations it occasionally ends in suppuration, a small collection of pus sometimes forming which discharges itself through the open end of the medullary canal. In simple fractures suppuration never takes place, but the products of the process are developed into bone, thus forming the internal callus (*vide* Repair of Fracture, Vol. I., p. 526).

Osteomyelitis in its early stages is recognized by the dark red colour of the marrow. Later on the fat disappears, and soft tissue, having the ordinary pink colour of granulation-tissue, takes its place. If bone forms it appears first in contact with the pre-existing osseous tissue.

Chronic osteomyelitis occurs only as a part of more general inflammatory affections of bone. Thus, in an osteoplastic osteitis, we often find the medullary canal encroached on by the newly-formed osseous tissue, until in some cases it is completely filled by spongy bone. In necrosis of the compact tissue the neighbouring medulla becomes chronically inflamed, and the products of the process undergo ossification.

Acute Diffuse Osteomyelitis is one of the most serious affections of bone. It occurs in two forms, traumatic and idiopathic. The traumatic is usually of septic origin, and is the direct consequence of decomposition of the discharges in a wound communicating with the medullary canal, as in a compound fracture or amputation. The products of putrefaction diffuse themselves in the soft tissue of the medulla and set up acute inflammation, which rapidly ends in suppuration, and often in gangrene of the marrow. There is nothing peculiar about the process, beyond the fact that the products being enclosed by the surrounding solid bone on all sides except at the opening into the canal, tend to diffuse themselves rapidly, often extending to the cancellous tissue at the articular ends.

Acute diffuse osteomyelitis may result also from the virus of the various infective inflammations which attack wounds, as erysipelas, hospital gangrene, &c., finding admission to the medullary canal. The distinction between these specific inflammations and that arising from the irritation caused by the products of simple putrefaction cannot usually be made, as it may be said that infective traumatic osteomyelitis never arises when the discharges of the wound are in an aseptic condition.

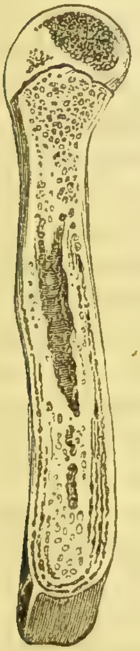


Fig. 500.—Diffuse osteomyelitis of Humerus, after Excision of the Elbow-Joint.

Idiopathic Infective Osteomyelitis is rarely met with, in this country at any rate, but is described as of frequent occurrence by most German writers; in fact, the cases which most English pathologists describe as acute infective or suppurative periostitis, or as acute necrosis, are by German writers spoken of as acute osteomyelitis. The disease is due to a virus, the nature of which is uncertain, but which is believed to be carried by the blood to the affected bone, and there to excite acute inflammation. The virus increases in quantity in the inflamed area, and by diffusing itself in the neighbouring parts causes the spread of the inflammation. What it is that determines the particular bone affected when the inflammation commences in the medulla is uncertain, but when the periosteum is primarily affected, and the medulla only implicated by extension through the compact tissue, the origin of the process can often be traced to a blow. Infective osteomyelitis has been artificially induced by injuring a bone subcutaneously and then injecting putrid fluids containing microscopic organisms into the blood-stream. In the human subject the pus from bones affected in this way can always be shown to contain micro-organisms. The form always met with is a micrococcus growing in groups like bunches of grapes and hence named staphylococcus. It is not peculiar to osteomyelitis, being met with in many other active suppurative inflammations.

A bone affected with acute diffuse osteomyelitis of any form presents the following appearances on section. The medulla is in parts redder than natural, and scattered hæmorrhages are commonly met with. In other parts it is paler in colour and infiltrated with pus, which here and there is collected in abscess-cavities of various sizes. At each end of the bone the morbid condition extends into the cancellous tissue, the marrow in the spaces presenting the same appearances. If the osteomyelitis is of the traumatic septic form, grey gangrenous patches of marrow are usually present, and the sawn bone is abominably offensive to the smell. The compact tissue shows no definite changes, but the periosteum is always swollen and frequently separated from the bone by the formation of pus beneath it.

Acute diffuse osteomyelitis always causes more or less extensive necrosis of the compact tissue, partly by depriving it of its vascular supply when suppuration takes place, and partly from extension of the diffuse inflammation into the Haversian canals. The veins of the affected bone become inflamed and filled with coagulum. The thrombi being invaded by the infective material, soften and disintegrate, and the fragments bearing with them the infective matter are carried into the circulation, and thus embolic pyæmia is a very common result of diffuse osteomyelitis.

INFLAMMATORY AFFECTIONS OF THE CANCELLOUS TISSUE.—The cancelli of the spongy tissue of bone are composed of osseous tissue differing in no respect save that of its arrangement from the compact substance. The spaces are filled with a marrow in most parts identical with that of the medullary canal, but containing less fat. In the vertebræ, ribs, and diploë of the skull, the marrow is red, and contains numerous cells like white corpuscles and others apparently intermediate between white and red. There is no reason to believe that any of the pathological changes observed in cancellous bone begin in the osseous tissue, the starting point of every process, as far as can be ascertained, being the medulla filling the cancellous spaces. The following are the chief inflammatory processes met with in the cancellous tissue :—1. Acute diffuse inflammation ; 2. Rarefactive osteitis, (*a*) without suppuration, (*b*) with suppuration ; 3. Osteoplastic osteitis.

Acute Diffuse Inflammation of the Cancellous Tissue is the same process occurring in the medulla of the cancellous tissue as has already been described under the name of acute diffuse osteomyelitis when attacking the marrow of a long bone, and arises under similar conditions, either as the result of the contact of putrid discharges in an open wound, implicating the spongy tissue of a bone, or as an infective process commencing without direct communication with the external air. In many cases it is merely an extension to the ends of the bone from the medullary canal. In it the cancellous spaces become filled with pus, or the medullary tissue may become gangrenous. It always leads to necrosis of the osseous tissue surrounding the spaces.

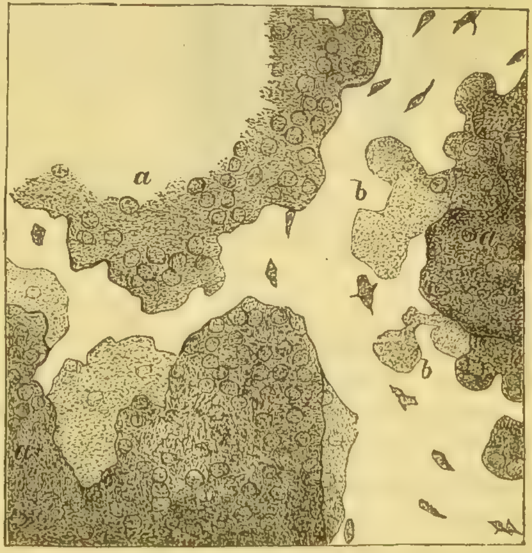


Fig. 501.—Carious Bone from a Case of Scrofulous Osteitis of the bones of the Skull in a child. At *b* are seen the so-called Lacunæ of Howship: the material filling the dilated Cancellous spaces *a* is more or less cheesy granulation-tissue.

Rarefying Osteitis is very common in spongy bones, and forms the chief pathological change in a large proportion of the cases clinically spoken of as *caries*. Rarefying osteitis in cancellous bone is essentially the same process as in the compact tissue. Inflammatory exudation and migration of white corpuscles take place in the medullary tissue, and the original structures disappear before the inflammatory new growth (Fig. 501). The cancelli become gradually thinned, being absorbed in exactly the same way as the lamellæ of the compact tissue. A spiculum of bone removed from the inflamed area shows the same irregular excavations or Howship's lacunæ, in most of which osteoclasts may be seen. The bone-corpuscles have frequently undergone fatty degeneration, sometimes the cells in the lacunæ are represented merely by oil globules. This is due to interference with the nutrition of the osseous tissue consequent on the changes occurring in the medulla of the cancellous spaces. Finally the bony tissue in the affected area may entirely disappear, the whole space being occupied by soft vascular granulation-tissue. This may be taken as the type of the process, but numerous modifications occur which require further consideration.

(*a*.) The granulation-tissue may grow exuberantly, with rapid destruction of the bony cancelli, and if reaching a surface, as the cavity of a joint, may form fungating projections. This form is termed *fungating caries* or *caries fungosa*. It is most common in the articular ends of bones.

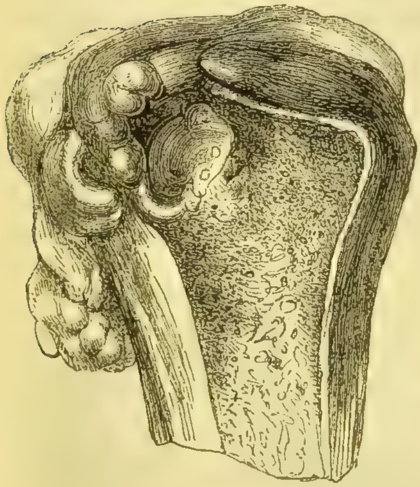


Fig. 502.—Scrofulous Vomica in Head of Tibia.

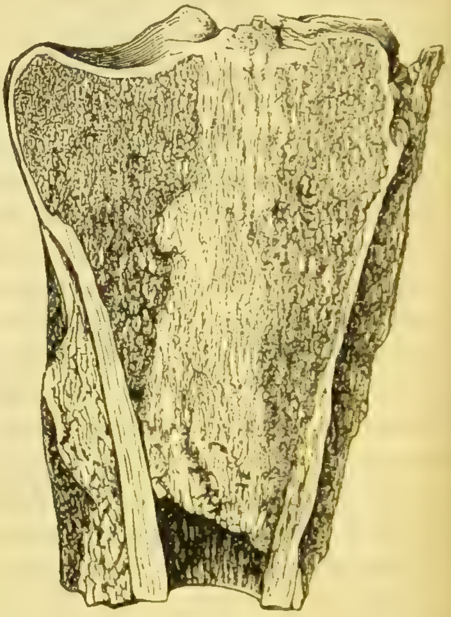


Fig. 503.—Chronic rarefactive osteitis of the Cancellous Tissue, with caseation of the inflammatory products.

(*b*.) After destruction of the bony matter the granulation-tissue may be absorbed and waste away without suppuration. This is most common where the diseased surface is exposed to pressure, as in the bodies of the vertebræ, or occasionally in joints. It leads to a progressive destruction of tissue, and from the absence of suppuration has been termed *dry caries* or *caries sicca*.

(*c*.) The granulation-tissue after destruction of the bony cancelli may break down into pus. When this occurs in the centre of a bone, the result is the formation of a chronic abscess surrounded by bone on all sides—*the chronic abscess of bone*. When the disease is situated near or on the surface of a short bone the periosteum is first raised by the pus and subsequently perforated, the chronic abscess then finding its way slowly to the surface. This forms the most common variety of ordinary *caries with suppuration*. In cases of wound of a joint with septic suppuration, after the cartilages have been destroyed, the exposed cancellous tissue is affected by a somewhat acute form of rarefying osteitis, in which the destruction of the granulation-tissue by suppuration follows closely on that of the bony cancelli. This is sometimes called *traumatic caries*, but is more commonly termed *ulceration* of bone.

(*d.*) The inflammatory process may end in suppuration before the cancelli have been completely destroyed. This is common in the more acute forms. The undestroyed osseous tissue in the affected area then perishes, and thus we get portions of necrosed cancellous bone of varying size surrounded by bone still being destroyed by the rarefying process. This condition is termed *necrotic caries* or *caries necrotica.*

(*e.*) The inflammatory products in the cancellous spaces frequently undergo fatty degeneration owing to the interference with their vascular supply from pressure consequent upon the rigid nature of the surrounding structure. If this occurs after the complete destruction of the osseous cancelli, the caseating mass frequently softens, and a *chronic abscess* results. If it occurs before the bony tissue is completely absorbed, such portions as remain perish, and a sequestrum composed of cancellous tissue with its spaces filled by cheesy matter results. This forms another variety of *necrotic caries.*

(*f.*) Occasionally the inflammatory products calcify. This seldom occurs to any great extent, but in examining a bone which has been affected by very chronic inflammation of the spongy tissue it is not uncommon to find opaque white patches of extreme hardness, which on careful examination can be seen to be composed of cancellous tissue, the spaces of which are filled with hard calcareous matter.

(*g.*) Lastly, rarefactive osteitis of the cancellous tissue may cease if the cause of the disease be removed, as when it is the result of friction of two diseased surfaces against each other, or when it is taking place round an abscess, or the pus has been discharged. The granulation-tissue then becomes converted into bone by the same processes as have been described in treating of rarefactive osteitis of the compact tissue.

The causes of rarefactive osteitis of the cancellous tissue are sometimes evident enough, as in the case of a wounded joint. In other cases they are very obscure. All forms of caries are common in scrofulous subjects, and it has at various times been asserted and denied that the process is very frequently the result of the deposit of tubercle in the cancellous tissue. Great attention has been paid to this subject of late years, and the conclusion most generally arrived at is that those forms associated with chronic suppuration or with caseation of the products of the inflammatory process are almost always, if not always, the result of tubercle. If a piece of carious body of a vertebra or of one of the short bones be properly softened and sections prepared for the microscope, the following appearances are often observed. The cancelli show the irregular erosions (Howship's lacunæ) already described, containing the osteoclasts ; the cancellous spaces are enlarged by the destruction of the surrounding bony tissue and filled with vascular granulation-tissue ; but here and there will be found non-vascular areas containing in the centre a giant-cell with branching processes, surrounded by the large so-called epithelioid cells, and around these again are lymphoid corpuscles, in fact a "tubercle nodule or follicle." That this is, in many cases at any rate, true tubercle, and not merely an accidental modification of the chronic inflammatory products, has been proved by the detection of the tubercle-bacillus in the nodule, and by the results of inoculation of the morbid products on the lower animals. The slow progressive infection of the neighbouring tissue, the caseation of the products of the process, the softening with the formation of curdy pus, and the occasional recovery by calcification, all agree with what we know of the mode of growth and progress of tubercle ; and although it is by no means proved that all cases of caries not evidently arising from other causes are tubercular, there is now no doubt that tubercle of the cancellous tissue of bones is a very common affection. In those cases of dry caries of the spine in which extensive destruction of the bodies of the vertebræ takes place, with absorption of part of the granulation-tissue and ossification of the remainder, ending finally in recovery, the evidence of a tubercular origin of the disease is necessarily wanting. It is probable that many such cases result from an injury occurring in an unhealthy subject, setting up inflammation which tends to persist partly on account of the constitutional weakness, the abnormal vulnerability of the tissues to use Virchow's expression, partly from the tension and pressure caused by the inflammatory exudation, but more especially by the friction of the diseased surfaces against each other.

Osteoplastic Osteitis affects the cancellous tissue with considerable frequency. It is characterized by thickening of the cancelli by formation of new bone upon them at the expense of the medullary tissue. The spongy bone thus becomes gradually denser in structure till it may closely resemble compact bone. The process of formation of the new bone is the same as in other parts. Osteoplastic osteitis of the compact tissue is often met with at the circumference of an area in which the rarefying process is going on, and thus not uncommonly a dense zone of bone is formed round a chronic abscess or a sequestrum. It is met with also in conjunction with chronic inflammatory processes in the compact tissue and in the neighbourhood of sequestra. In other cases it may occur as a sequence of the rarefactive inflammation, the formation of new bone on the cessation of that process exceeding the normal limits.

Necrosis of the Cancellous Tissue is of common occurrence. It has already been sufficiently described under rarefactive osteitis.

PERIOSTITIS

Inflammation of the Periosteum is common as a result of injuries, syphilis, or rheumatism, or as a morbid process dependent on disease of the subjacent bone. It frequently occurs in the neighbourhood of joints as the result of extension from the inflamed ligaments.

Symptoms.—*Simple Acute Periostitis* (p. 260) resulting from injury, such as a blow on a superficial bone, as the tibia, is characterized by the formation of a swelling, fixed on the surface of the bone, acutely tender, and accompanied by severe tensive aching pain, especially when the limb is in a dependent position. The skin may be slightly reddened and œdematous. Under proper treatment the symptoms soon subside in most cases, but occasionally the inflammation goes on to suppuration. In simple periostitis the pus shows but little tendency to burrow beneath the membrane, in this differing essentially from the diffuse or infective subperiosteal suppuration to be described presently (see Acute Infective Periostitis). The simple subperiosteal abscess may be followed by necrosis of a scale of bone, but more commonly after the pus is evacuated it heals without further trouble.

Subacute and Chronic Periostitis may occur as a sequence of the acute form just described; or the disease may from the beginning assume this form when it is due to syphilis, rheumatism, or occurs in a scrofulous subject. Chronic periostitis is always accompanied sooner or later by the formation of new bone (Osteoplastic Periostitis, see p. 262). The symptoms consist of a hard, elongated, but somewhat puffy swelling without cutaneous discoloration—a *node*—not distinctly circumscribed, and attended by much pain in the part, especially at night, with tenderness on pressure.

Treatment.—In the treatment of the *acute form* of the affection, the free applications of leeches, with hot fomentations, will arrest the disease, and give relief to the patient. Should pus form it must be let out by incision as soon as it is recognized, strict antiseptic precautions being observed in order to diminish the risk of necrosis.

In the more *chronic form*, the continued administration of the iodide of potassium will take down the swelling, remove the nocturnal pains, and materially improve the local condition of the part. In those cases of periostitis which are of syphilitic character, iodide of potassium may be looked upon almost as a specific. Added to this, repeated blistering will be of essential service. If there be much thickening, the parts suffer from the tension of the structures; here considerable relief will be afforded by the free division of the periosteum down to the bone, either through the skin, or subcutaneously by means of a tenotome slid under it.

CHRONIC OSTEITIS AND PERIOSTITIS.

By **Chronic Osteitis and Periostitis** is meant an affection usually attacking long bones, leading to considerable enlargement, with alteration in structure. A section of the affected bone shows that the periosteum is thickened and new bone is being formed beneath it (Osteoplastic Periostitis, p. 262). The compact tissue has become more porous than natural, and from the simultaneous destruction of the old bone and formation of new, it often shows a peculiar laminated expansion of its structure, so that a section of it presents an appearance of concentric parallel layers (Rarefying Osteitis and Expansion of Bone, pp. 264, 266). The cancellous tissue may at the same time become denser than natural, and new bone may form, filling the medullary canal (Osteoplastic Osteitis of the Cancellous tissue, p. 272). As the result of these changes in its various component parts, the whole bone may be converted into a uniform mass with but little distinction between the cancellous and compact tissue. When the process becomes extremely chronic, as it often does, the osteoplastic processes may be more pronounced, and the enlarged bone become extremely dense and ivory-like in structure. Chronic osteitis and periostitis may occur alone, but it is more common to find it associated with necrosis of small portions of the cancellous or central layers of the compact tissue, or with the presence of a chronic abscess in the cancellous tissue. The disease may affect the whole length of a bone (Fig. 506), or may be limited to one end. When it occurs in young subjects it is often accompanied by early union of the epiphyses, which may cause shortening from want of growth. In other cases in which the middle part of the bone is chiefly affected, elongation may take place. I have seen, as the result of chronic osteitis, the tibia from one and a half to two inches longer than its fellow.

Causes.—Chronic osteitis may arise from various causes. In some cases it is met with in strumous children, and appears to arise from slight traumatic causes or from exposure to cold. In those cases in which it is limited to one end of a bone, it is often due to the irritation caused by the presence of a small tubercular centre deeply seated in the cancellous tissue. When the middle part of the bone is affected, especially before cessation of growth, it will not uncommonly be found to be due to hereditary syphilis. In adult life it is often one of the effects of acquired syphilis.

Symptoms.—The symptoms of chronic osteitis consist of enlargement of the affected bone, with deeply seated pain in and great tenderness of the limb ; the pain, as in periostitis, is greatly increased at night, and, when the disease is chronic, is much influenced by the state of the weather. There is no danger connected with this condition ; but it often becomes distressing from the severity of the tensive and nocturnal pain accompanying it. In strumous subjects there is danger of the process becoming intensified in parts of the bone, and thus leading to necrosis or caries with chronic suppuration.

Treatment.—In chronic osteitis and periostitis, when the bone has become thickened and enlarged, but little can be done in the way of cure. The administration of iodide of potassium with occasional application of blisters will however do much to arrest the progress of the disease and relieve pain, especially in those cases in which there is a syphilitic taint. Should these means fail in giving relief, and the pain continue of an excessively distressing and persistent character, I have for many years past practised the following operation of *linear osteotomy*. An incision about three inches long is made directly down on the chronically inflamed and indurated bone, being carried through the periosteum, so that the scalpel grates upon the bone. By means of a Hey's saw this cut is extended into the substance of the bone as far as the medullary canal, or deeply into the cancellous tissue. Some bleeding occurs, but it can always be arrested by position and pressure. The wound is then closed. In this way tension is taken off ; and the pain, which appears to be dependent on the compression of inflamed bone by its own condensed structure, is at once relieved. "Linear osteotomy" is an operation especially applicable to osseous nodes of the long bones, or to chronic osteitis of the articular ends of the tibia, and is a far less severe mode of treatment than trephining the bone, which has occasionally been adopted in such cases ; while it is equally efficacious. After a time, when the progress of the disease ceases, the enlarged bone does not give rise to any very serious inconvenience, except such as may be occasioned by its bulk.

CHRONIC ABSCESS OF BONE.

Chronic abscesses in bone are usually met with in the cancellous tissue, and occur with special frequency in the head and lower end of the tibia. The abscess forms as the result of rarefying osteitis of a localized portion of the cancellous tissue (p. 264). This process continues till the bony cancelli are completely destroyed. Subsequently the inflammatory products undergo fatty degeneration and soften, forming thick curdy fluid containing few recognizable pus-cells and large quantities of fatty *débris*. The process may continue gradually to extend, and may thus undermine the contiguous cartilage, and eventually the abscess may burst into the neighbouring joint (Fig. 504). The tendency for the pus to burrow in this direction is increased by the want of formation of any new bone beneath the cartilage, while it readily takes place under the periosteum. In young subjects before the union of the epiphyses, the pus commonly finds its way to the surface through the soft tissue between the epiphysis and the diaphysis. Very frequently, however, the disease becomes excessively chronic. The abscess is then of small size and deeply seated in the cancellous tissue. The inflammation in the bone immediately surrounding the cavity in these cases often assumes the osteoplastic form, and the collection of pus becomes surrounded by a wall of excessively dense hard bone, and in this state it may remain unchanged for many months or even years. The irritation caused by the presence of the pus usually gives rise to chronic inflammatory changes in the neighbouring compact tissue and periosteum. These assume the form described in the previous page as "chronic osteitis and periostitis," and produce considerable enlargement of the affected end of the bone. Chronic abscesses have been occasionally, but more rarely, met with in the medullary canal.

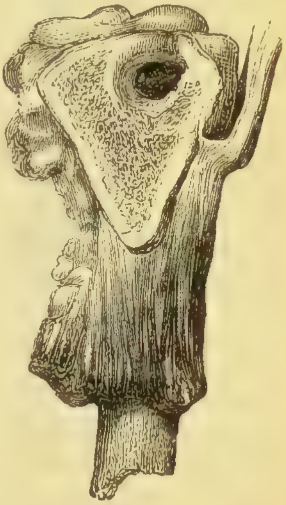


Fig. 504.—Abscess in the Head of the Tibia.

The quantity of pus contained in a chronic abscess of bone is usually very small, amounting to one or two drachms, but Stanley has recorded cases in which an ounce or more was found.

It may happen that degeneration of the inflammatory products or suppuration may take place before the rarefying process has advanced far enough to cause complete destruction of the cancellous tissue. The undestroyed bone then perishes, becomes separated from the surrounding parts, and lies loose in the cavity of the abscess.

In some cases abscess of bone is associated with chronic osteitis of a considerable portion or the whole of the shaft, the bone becoming greatly enlarged, thickened, and generally diseased from end to end. Fig. 506 is a representation of a section of the tibia in such a state of combined suppuration and inflammatory hypertrophy, removed by amputation from a woman who had suffered for 23 years from the disease. In such cases, amputation or excision is the sole means of relief.

The **Causes of Chronic Abscess of Bone** are often somewhat doubtful. It occurs almost exclusively in scrofulous subjects, and there can be no doubt that the immediate cause in a very large proportion of cases is the deposit of tubercle in the medulla of the cancellous tissue. This sets up inflammation around it, and finally softens in the same way as in other parts. In some cases the disease arises apparently from injury.

The **Symptoms** of chronic abscess of bone are usually of the following character. The patient, after the receipt of an injury, perhaps, has noticed that at one spot the affected bone has become swollen and painful; the skin covering it preserves its natural colour in the majority of cases, but in some instances becomes red, glazed, and œdematous; the pain, which is of a lancinating and aching character, is usually remittent, often ceasing for days, weeks, or months, and then returning, under the influence of very trivial causes, with its original severity. It is especially troublesome at night, and is always associated with a degree of tenderness of the part; and, indeed, in the intervals of its accession, it will be found on careful examination that there is always one tender spot in the enlarged and indurated bone. The long persistence, for years perhaps, of these signs will usually point to the existence of a small circumscribed abscess under the thickened wall of the bone. It must be borne in mind, however, that the same local symptoms may be induced by four conditions: 1. By a chronic abscess without necrosis. 2. By the inclusion of a small piece of dead bone surrounded by pus within a dense and impervious casing. 3. By simple or syphilitic osteitis and periostitis (p. 273), without suppuration or necrosis; and, 4. By the growth of a tumour within the bone. For all practical purposes the diagnosis is of little consequence, as the operative process is the same, whether the symptoms arise from the confinement of a few drops of pus or from the inclusion of necrosed bone, and the diagnosis of the presence of a tumour can often be made only by a similar operation.

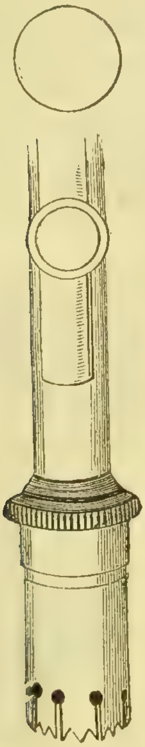


Fig. 505.—Bone Trephine.

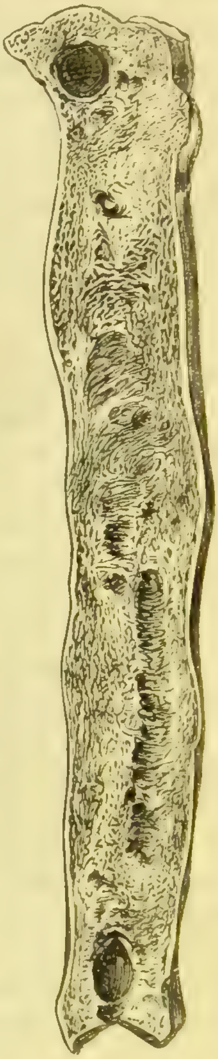


Fig. 506. — Section of Tibia, showing Chronic Osteitis and Circumscribed Abscesses of many years' duration.

The danger of chronic abscess of the end of a long bone will greatly depend on its proximity to the articular surface. If near this, it will probably lead to perforation of the cartilage, so that the pus enters the joint, which then becomes acutely inflamed and often destroyed. If the abscess is due to the presence of softening tubercle the synovial membrane may become infected, and chronic tubercular disease of the joint (white swelling) may thus be set up.

If the chronic abscess be situated in the diaphysis near the junction of the epiphysis with the shaft, this event is not so likely to occur. The surrounding bone simply becomes thickened ; and though the health may suffer from the constant wearing pain, the joint is not in peril, and relief may readily be given by operation.

Treatment.—As a circumscribed abscess in bone cannot perforate the dense osseous structure overlying it by any process analogous to the pointing and discharge of an abscess in the soft parts, it becomes necessary for the Surgeon to open up a vent for the pus. This may be done either by linear osteotomy or by the trephine. In some cases simple linear osteotomy, as described at p. 274, may be practised ; but should the bone be much thickened and the osseous structures greatly indurated, an efficient aperture can only be made by means of the trephine. So soon as a vent has been given to the pus, which is usually curdy, the patient will experience great and permanent relief. In performing this operation, the limb having been made bloodless by Esmarch's method, the bone must be exposed by a T- or V-shaped incision, made over the spot which has been found to be uniformly tender on pressure ; and to this the trephine should be applied. The trephine should have a small and deep crown of the size and shape represented in Fig. 505 ; and it is well always to be provided with two instruments of exactly the same shape and size, lest one become disabled by the density of the osseous case, as I have seen happen. When the trephine has penetrated to a sufficient depth, the button of bone may be removed by means of an elevator ; but care should be taken not to perforate the whole thickness of the bone. The diseased cavity will very commonly at once be opened in this way, a small quantity of pus escaping, which may, if the limb be not bloodless, be readily overlooked, as it is carried away in streaks with the blood, which flows freely from the cut bone. Should no pus escape, perhaps a portion of dead bone may be exposed ; if so, it must be removed with a gouge. But if neither of these conditions be found, the Surgeon must not be disappointed, but should pierce the neighbouring osseous tissue in different directions by means of a perforator, when perhaps the abscess will be opened ; should it not be so, the patient will still in all probability be materially benefited by the removal of the circle of bone, and the consequent relief to the compression of the osseous tissue.

The operation should, if possible, be performed with antiseptic precautions. The cavity should be thoroughly cleaned with a small piece of sponge soaked in some antiseptic solution (as chloride of zinc, gr. xx. to ℥j.), in order to remove any fragments of necrosed bone or saw-dust. It may then be dressed with any efficient antiseptic dressing. Among the best are carbolic gauze, and absorbent iodoform or salicylic wool. The dry wool dressings may be left unchanged, if all goes on well, for a week or even a month if no discharge soaks through. If decomposition can be prevented the cavity often becomes filled with a blood-clot into which the granulation-tissue rapidly sprouts from the surrounding bone, until in two or three weeks it may be completely closed. If the cavity becomes filled with septic discharges the process of healing is much delayed. Subsequently the granulation-tissue develops into bone and the limb recovers its former strength and utility.

DIFFUSE SEPTIC OSTEOMYELITIS.

Diffuse acute inflammation, ending in suppuration of the medullary tissue of a bone, may arise as a consequence of open injuries, such as compound fractures or amputations, or occur as an acute disease arising without evident cause. I shall here deal only with the former condition, the latter being most conveniently considered when discussing the disease commonly known in this country as "acute necrosis."

Acute septic osteomyelitis was formerly a common consequence of injuries by which the medullary canal was opened, such as compound fractures or amputations, and it was also often met with when the cancellous tissue only was implicated, as in excision of the knee. Compound fissured fractures of the long bones, such as result from gunshot wounds, are specially prone to be followed by it. The condition is essentially connected with decomposition of the discharges of the wound through which the bone has been exposed, and more especially with the presence of septic matter pent up in contact with the open medullary canal or cancellous tissue. The improved treatment of wounds and the use of antiseptics have now almost abolished it in civil practice though it is still not uncommon in military surgery.

In certain rare cases diffuse osteomyelitis has been met with as the result of subcutaneous injuries. In the majority of these cases it formed a secondary effect of general blood-poisoning from a foul wound on some other part of the body. That this is the most probable explanation of these cases is shown by the fact that simple fractures can be made to suppurate in animals, and osteomyelitis can often be induced in the injured bone by injecting septic matter into the blood-stream.

The pathology of the process is not difficult to understand. If septic matter be pent up in the deep parts of a wound in contact with the opened cancellous tissue or the medullary canal, the products of decomposition will readily diffuse themselves into the soft medullary tissue. This becomes acutely inflamed, and pus is rapidly formed; or owing to the confined space in which the medullary tissue is contained, the inflammatory swelling may arrest the circulation and cause gangrene. Whether it ends in gangrene or suppuration the products of the inflammation in their turn decompose, and thus the process rapidly spreads throughout the medullary tissue. Simple putrefaction is thus sufficient, in most cases, to explain the phenomena of diffuse osteomyelitis, without supposing that any specific virus is present. It is probable, however, that in many cases the wound is really infected with some specific virus analogous to that of phlegmonous erysipelas or spreading gangrene, for diffuse osteomyelitis may attack several patients in one ward at the same time, and, in fact, is predisposed to by all those conditions which have already been described as influencing the occurrence of other infective processes in wounds. The pus and gangrenous medulla are always found to contain microscopic organisms, but they are not uniform in character. The process is often accompanied by offensive decomposition and blackening of the gangrenous tissues from the generation of sulphuretted hydrogen. Septic osteomyelitis is one of the most common causes of embolic pyæmia. The connection between these conditions has been specially pointed out by Sir Joseph Fayrer, who has had abundant opportunities of studying the disease in India. The frequency with which pyæmia follows this affection is due to the fact that the veins of bone, lying as they do in rigid canals, cannot collapse, a condition highly favourable to the extension of thrombosis. The thrombi thus formed become impregnated with the products of the unhealthy process, disintegrate, and are washed on into the blood-stream, causing centres of suppuration wherever they lodge. It is this that makes septic osteomyelitis a most dangerous disease, frequently proving fatal.

Fat-embolism has been observed in many cases of acute osteomyelitis, the liquid fat from the broken down marrow being forced into the vessels or lymphatics by the pressure of the inflammatory exudation. If the emboli are impregnated with the products of decomposition, they may give rise to abscesses in distant parts where they lodge.

If the patient escape the dangers of pyæmia, the disease almost invariably leads to more or less extensive necrosis affecting chiefly the inner layer of the compact tissue. The long sequestra so frequently removed from stumps, especially after amputation of the thigh, are the result of this process (see Vol. I., p. 74).

After death, the appearances presented by the inflamed bone will, if it have been the seat of compound fracture, be usually most marked in the upper fragment; if it have been the seat of amputation or excision, they will extend through the whole of the bone that is left. They are as follows. The periosteum and outer surface of the bone will appear to be slightly injected. On making a longitudinal section of the bone, the medullary canal is found to be filled with pus or a reddish puriform fluid, often abominably offensive; the medulla is swollen, soft, pulpy, of a deep red or reddish-brown colour; the compact bone has a pinkish tinge, and the cancellous osseous structure is often of a bright rosy hue. In a case of compound fracture, the contrast between the deep coloration of the inflamed portion of bone and the naturally pallid appearance presented by that which is not diseased, and more particularly the deep red hue of the medulla in the one, and the pale yellowish waxy-looking fat filling the medullary canal in the other, is most striking. Fayrer describes the medullary canal, in advanced stages of the disease, as being filled with a mass of dead blackened medulla, *débris* of bone, and pus.

Symptoms.—In acute osteomyelitis, after an injury to or an operation involving the bone, the limb swells, with deep-seated severe aching pain and much tenderness. Abscesses form often unconnected with the original wound, and profuse suppuration is established. The suppuration may amount to many ounces of pus in the day, and the discharge is often dark-coloured and fetid. The soft parts retract from the bone, and this where exposed is dry, yellow and dead, being denuded of periosteum. Septic inflammation and suppuration of the diploe are not uncommon in head injuries. In such cases the scalp is swollen, the periosteum loosened from the bone, and the outer table dry and bare. If the outer table be cut away after death, the diploe will be found infiltrated by offensive pus.

The *constitutional symptoms* are those of severe septic fever. The temperature is seldom below 103° F. In many cases the symptoms soon become those of acute pyæmia. If the patient escapes pyæmia the fever subsides, and subsequent symptoms are merely those dependent upon the presence of the necrosed bone.

Treatment consists in supporting the patient's strength by a tonic and stimulating regimen, and by scrupulous attention to hygienic rules.

The less acute forms of the disease call for no treatment beyond attention to cleanliness while the sequestra are becoming loose enough for removal.

In the more acute forms which threaten to terminate in pyæmia, nothing can be done so far as the affected bone is concerned, except its removal ; but whether this should be done in the continuity of the bone or at the joint above, is a question on which different opinions are entertained among surgical authorities. If an operation be performed upon the continuity of a bone affected with diffuse suppuration in the medullary canal, the septic inflammation will almost certainly recur in the part of the bone which is left. Hence, it is strongly urged by some Surgeons, especially by J. Roux, that the operation should be performed at the joint above the diseased bone, in preference to amputation through its continuity. Roux, who had extensive experience in the Italian war of 1859, successfully disarticulated the thigh at the hip-joint, in four cases of osteomyelitis consequent on gunshot-injuries of the lower end of the femur. Of 22 cases in which he performed secondary disarticulation at other joints for osteomyelitis, all recovered ; whereas every case terminated fatally in which the amputation was performed through the continuity of the injured bone after the battles of Magenta, Montebello, Marignano, and Solferino. On the other hand, Larrey did not consider disarticulation absolutely indispensable, even in cases of acute osteomyelitis ; and Longmore has met with cases in which recovery has followed the simple removal of portions of dead bone—the disease in these instances having assumed a chronic form. Fayrer advises that, where osteomyelitis is suspected to be present in a stump after amputation, the medulla should be examined by a probe. If this soon impinge on healthy bleeding medulla, the Surgeon may wait for the efforts of nature to throw off the diseased bone ; if, on the other hand, the probe encounter only dead bone and pus, then the sooner amputation is performed the better.

The special danger in osteomyelitis consists in the tendency to the supervention of osteophlebitis and pyæmia ; and, in deciding upon the amputation or exarticulation of a bone thus affected, it is of the first importance not to delay the operation until pyæmic symptoms have set in. There is a period between the development of the local inflammation and the pyæmic infection, which should not be let slip by. During this period the patient is affected by septic fever, but there are no rigors. If once the characteristic rigors and the irregular temperature and profuse sweats of pyæmia have set in, I believe that operation can be of no use, as the patient will certainly perish from secondary abscesses or general blood-poisoning. But, before rigors have occurred, the amputation may be done with a good prospect of success. The unsuccessful results of the treatment of this disease renders it all the more imperatively necessary to prevent it by the adoption of efficient antiseptic dressing and proper attention to the hygienic surroundings of the patient. In military practice, however, this is not always possible.

It has been suggested, instead of amputating at once, to scoop out the medulla with a sharp spoon and to introduce iodoform into the canal. Perkowski has recently recorded 8 cases in which he carried out this treatment when the symptoms of osteomyelitis had set in after amputations. In three the whole of the medullary canal remaining was scraped out, and in the other five a length of from 1½ to 3 inches was treated in this way ; all recovered without pyæmia. The treatment certainly deserves a trial when amputation is for any reason unadvisable.

ACUTE NECROSIS.

ACUTE NECROSIS is an acute infective inflammation almost exclusively met with before the growth of the skeleton has completely ceased. The affection is known by many other names, such as acute diffuse periostitis, phlegmonous periostitis, infective periostitis, infective periostitis and osteomyelitis, acute infective osteomyelitis, acute suppurative epiphysitis, necrosial fever and bone-typhus ; but the term "acute necrosis" is perhaps the best in the present state of our knowledge, as it does not imply any theory as to the exact nature of the disease and starting point of the inflammation.

Symptoms.—A typical case of acute necrosis presents the following symptoms. The patient is usually a child below the age of puberty, and most commonly a male. He is often strumous and usually in somewhat feeble health, possibly the result of a recent attack of some acute specific disease, as scarlet fever or measles. There is in most cases a history of some slight injury, but this is by no means constant. The attack begins with a sudden invasion like that of a specific fever. There is high temperature, often reaching 105° F. or even higher, occasionally with a rigor. Headache, loss of appetite, thirst, and sometimes vomiting or diarrhœa are present. At first the local affection may escape observation, and such cases are not unfrequently mistaken at the commencement for one of the acute specific diseases. By the second or third day, however, the local symptoms become manifest. The parts covering one of the long bones, most commonly the tibia, femur or humerus, are found to be swollen and acutely tender. At first the skin is pale, but it soon becomes reddened. By the fourth or fifth day, or sometimes not till the end of a week, distinct fluctuation is recognized, often extending over the whole of the shaft of the affected bone. At this time on moving the limb, distinct, though somewhat soft crepitus may be felt, and it will then be found that one, or sometimes both the epiphyses may be loosened from the diaphysis. As a rule the joints escape, but occasionally one or both of the articulations into which the bone enters become distended with fluid. If at this stage an incision be made into the swollen parts down to the bone, a large quantity of pus escapes, and on inserting the finger the greater part of the diaphysis may be felt to be denuded of its periosteum. All this time the febrile disturbance persists, and by the end of a week may assume the ordinary characters of pyæmia. Symptoms of pneumonia, pleurisy and pericarditis and endocarditis may supervene and death take place before the abscess has been opened. The disease does not, however, always run this typical course. The following are the chief modifications met with. The threatened suppuration in some very rare cases does not take place. The inflammation of the periosteum gradually subsides in intensity, and assumes the osteoplastic form. A case of this kind occurred lately in University College Hospital in a youth aged about 19. No suppuration took place, the acute symptoms rapidly subsided, and the femur became gradually enlarged to more than double its natural size throughout the whole shaft, from formation of new bone under the periosteum. In other cases, although pus forms early, the extent to which the periosteum is raised from the bone is more limited, being confined to one end or the middle of the shaft. In these cases the course of the disease is usually less acute, and the abscess may become localized and gradually point towards the surface. Separation of the epiphyses is by no means a constant occurrence; the younger the patient the more likely is it to occur. Billroth states that a disease of exactly the same character may occur in adults, but this is somewhat doubtful.

Pathology.—Much difference of opinion still exists as to the exact nature of this disease and its point of origin. Holmes, and with him most English Surgeons, regard it as an acute diffuse inflammation commencing in the periosteum. Dent and others have published cases proving that at any rate it often arises in this way. In Germany and France it is more commonly described as acute osteo-myelitis, and is believed to commence in the medulla. There is no doubt that in fatal cases it is very common to find the medulla inflamed and often suppurating, but this is by no means constant, and in many cases at least is evidently secondary. In a case which lately occurred in University College Hospital, a section of the bone showed the medulla to be inflamed on one side only, in contact with the part of the compact tissue which was denuded of its periosteum, the remainder of the marrow being perfectly healthy. The inflammation was evidently of a more recent date than that of the periosteum. Others have supposed that the compact tissue is primarily affected, but of this there is no evidence. That the inflammation is infective in character is shown by its tendency to spread, and by the frequency with which it is followed by pyæmia, even before the abscess has been opened. The fact that the pus in acute necrosis contains micrococci was demonstrated by Lücke and Klebs as long ago as 1874. In 1880 Pasteur cultivated the organisms obtained from a case of this disease, and pointed out their similarity or identity with those he had found in common boils, and the further researches of Becker in 1883, and Rosenbach in 1884, added greatly to our knowledge of the characters and properties of the micrococcus. The results of these observations may be briefly summarised as follows:—If a minute drop of pus from a freshly opened abscess in acute necrosis be placed upon a prepared potato or the gelatine cultivating medium, an opaque orange-coloured patch soon appears, and gradually increases in size until it comes to resemble a spot of orange-yellow oil paint. More rarely the spot is opaque white in colour. Microscopic examination shows this is due to the growth of a small micrococcus, to which Rosenbach gave the name of the staphylococcus pyogenes aureus or albus. Microscopically the orange and white forms are indistinguishable. The individual micrococci are arranged in irregular groups somewhat resembling bunches of grapes and showing no tendency to form chains. They rapidly liquefy the gelatine upon which they are growing, and peptones are abundantly present in the liquid thus formed. They give rise to no gas in their growth, but the liquefied gelatine has an unpleasant smell, like sour paste. These organisms are, however, by no means limited to acute necrosis, but are met with in many other acute suppurative processes, such as boils, acute mammary abscess, some cases of empyema, thecal abscess, suppurating wounds, the secondary abscesses of pyæmia, &c. In fact the staphylococcus pyogenes, either in the white or yellow form, is the most common organism met with in all forms of acute suppuration. Becker, Krause, Peyroud, and others have shown that the organism is by itself an efficient cause of suppuration. If a pure cultivation diffused in sterilized distilled water, is injected into the veins of a rabbit it may cause rapid death with symptoms resembling septicæmia. Smaller quantities have caused death at a period as late as the seventh day, and with centres of suppuration have been found in the joints, muscles, kidneys, and, according to Krause, in the marrow of long bones. In these cases pure cultivations of the staphylococcus have been obtained from the blood. If a smaller quantity be injected and a long bone bruised or broken, suppuration follows at the injured part. Lastly, Garré, by rubbing a pure cultivation from a case of acute necrosis into his arm, caused the development of a crop of boils. It seems, therefore, to be almost proved that acute necrosis is caused by the staphylococcus entering the body in some way from without. If the conditions are not favourable for its development, it is destroyed in the blood, probably by the corpuscles. On the other hand it may find a nidus for its development in the soft growing tissue beneath the periosteum, or in the layer between the cartilage of the epiphysis and the diaphysis, the point being determined probably by some slight injury. If it develops it excites inflammation and suppuration at the point at which it is growing and increases in quantity in the inflammatory exudations. It may then enter the circulation again in large quantities and be disseminated through the body, as in the experimental injections in animals, thus giving rise to disseminated suppurations in distant parts, or, in other words, to pyæmia. It is probable that under ordinary circumstances at least the organism does not multiply in the blood but is merely carried by it. The mode of entrance of the organism into the body and its habitat out of the body are still uncertain. In very rare cases acute necrosis is preceded by an unhealthy wound or sore on the surface of the body, but, as a rule, no such source of infection is present. The rapid extension of the suppuration beneath the periosteum is due partly to the infective nature of the pus and partly to the fact that it is pent up beneath the dense fibrous layer of that membrane.

Results.—As the name "acute necrosis" implies, the disease almost invariably results in more or less extensive death of the compact tissue. The extent of the necrosis by no means necessarily corresponds to the area from which the periosteum has been raised by the pus, for after this has been evacuated, the membrane may adhere again to a considerable extent, and the connection between its vessels and those of the bone be re-established. In a case lately in University College Hospital the tibia was felt to be bare from one end of the shaft to the other, yet after free incisions were made no necrosis followed, except over an area of about one square inch near the lower end. The after-history of the dead bone, the process of separation of the sequestrum and repair, will be fully described with necrosis in general.

Diagnosis.—Before the local symptoms become evident, especially in fat children, the disease is easily mistaken for one of the acute specific fevers. So likely is this to happen, that in cases of sudden severe febrile disturbance of doubtful nature in children, the bones should always be examined. When the swelling sets in, it may be mistaken for phlegmonous erysipelas or cellulitis, but these conditions are rare in childhood. When pus is suspected, a puncture should be made with a grooved needle or an aspirator, by which the diagnosis can usually be cleared up. When an epiphysis is separated the affection may be mistaken for disease of the neighbouring joint.

Prognosis.—The prognosis of acute necrosis is always grave, but as

Billroth points out, it is probably not so fatal as hospital statistics would make it appear. The milder cases, in which the extension of the inflammation is limited, are often treated at home, and come under hospital treatment only at a later period, for removal of the sequestra. In fact, the great majority of cases of extensive necrosis of the long bones in young subjects are the result of this disease.

Treatment.—The only treatment is to cut down upon the bone and let out the pus at the earliest possible period. In the thigh the incision is best made on the outer side; in the leg in front, over the tibia. If the lower end of the femur is chiefly affected the incision should be parallel to the anterior border of the biceps. In this way the ham may be opened up without endangering the synovial pouch of the knee. The incisions must be free, and if necessary several may be made. The wounds must be well drained and treated antiseptically. If the discharges be allowed to decompose, the danger of the patient will be greatly increased. The result of the treatment is to relieve immediately the constitutional symptoms and arrest the progress of the disease, but in a certain proportion of cases general infection may have taken place before the abscess is recognized, and the result is then always fatal.

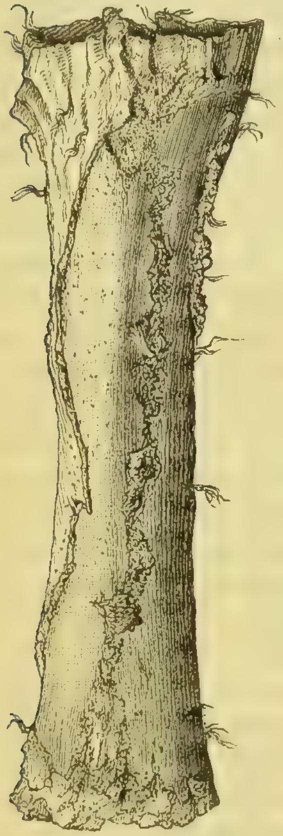


Fig. 507.—The diaphysis of the Tibia removed early in a case of acute necrosis. The whole shaft is not dead, but is partly covered by a thin adherent layer of new bone, shown on the left side of the figure.

If after the incisions have been made the discharge remains very profuse and threatens to exhaust the patient, amputation may sometimes be necessary. In the arm or thigh, as there is only a single bone, a splint must be applied, lest spontaneous fracture should occur. If the shaft of the bone is separated at each end from the epiphyses and lies loose in the cavity of the abscess, it becomes a question whether it should be removed at once or left in the hope that it may partly recover or may at least serve as a support during the formation of the new bone from the periosteum. Numerous cases have been recorded by Holmes, J. Bell, Macnamara and others, in which early removal has been practised with excellent results. Fig. 507 represents the shaft of the tibia removed in this way by C. Heath with a most satisfactory result. New bone is slowly formed from the periosteum, and after a few months the limb is in most cases almost as strong as before the operation. The removal of the bone can usually be accomplished by simply exposing it by a free incision, laying hold of it with the lion forceps and twisting it out. In some cases the operation is facilitated by dividing the shaft into two pieces with a chain-saw. If the bone on examination be found to be firmly attached it should be left alone. It is only in those cases in which there is reason to believe that the whole diaphysis is separated from the periosteum and the epiphyses that the operation is justifiable.

CARIES.

The term **Caries** has been used with considerable laxity, so that it cannot be said to have any definite pathological meaning. It is in fact applied to every slowly progressive ulceration of bone except that concerned in the separation of a sequestrum from the surrounding living bone. All these processes belong to the class of rarefying inflammations of bone, that is to say, the bony tissue is gradually absorbed before an advancing inflammatory new growth proceeding from the vascular tissue, either in the medulla of cancellous bone, or in the Haversian canals of compact bone. These processes have already been described (pp. 264, 269).

The modifications of caries depend upon the cause of the disease, the part of the bone affected, and the stage of the process in which suppuration, or degeneration of the inflammatory products take place.

Causes and Varieties of Caries.—Caries may be divided according to its cause into *simple, tubercular* and *syphilitic.* All forms are predisposed to by those constitutional conditions which predispose to inflammation generally. The disease is common in strumous subjects, in whom, as before stated (see Scrofula, Vol. I., p. 1090), inflammation is prone to be set up by slight causes and to persist.

Simple Caries occurs under various conditions. When a joint has been wounded, and suppuration with destruction of the cartilages has taken place, the progressive ulceration that may occur in the exposed cancellous tissue is commonly spoken of as caries. In this case it is due partly to the irritation of the septic discharges, but chiefly to the friction of the diseased surfaces against each other. It seems probable, also, that in some cases of caries of the spine, the disease may originate in an injury of the soft growing tissue between the epiphyses and the body as the result of some concussion or forcible flexion. Owing to some constitutional weakness on the part of the patient, and still more to the slight mechanical irritation which must occur whenever the part is moved or the weight of the body thrown upon it, chronic rarefying osteitis may be set up, with progressive destruction of the bone. This may occur without the formation of pus, as in the condition known as "dry caries." That the persistence of the process is in many cases due solely to the friction of the diseased surfaces upon each other is shown by the readiness with which cure takes place when this is prevented and perfect rest is obtained. Thus, in traumatic caries of a joint, if the limb be fixed so that all movement is impossible, or if the articular surfaces become separated by dislocation, the carious bone usually heals rapidly.

In these cases of simple caries if a section of the bone be made perpendicular to the carious surface the disease will be found not to extend to any great depth. In the layer that is affected the bony cancelli are thinned and in part destroyed near the surface, so that in a macerated specimen the tissue looks more spongy than natural. In the spaces the normal medullary fat is replaced by granulation tissue.

Tubercular Caries is by far the most common form of the disease. The observations of all pathologists during the last few years have tended to prove that the great majority at least of all cases of caries affecting the vertebræ, the short bones of the hand and foot, and the cancellous tissue of the heads of the long bones are dependent upon the presence of tubercle. Not only is the anatomical structure of tubercle, the tubercle nodule or follicle (see Vol. I., p. 1082), present with great frequency in the diseased cancellous spaces, but the presence of the tubercle bacillus has been repeatedly demonstrated by the microscope and by inoculation on animals.

The fact that Billroth has found cheesy tubercular deposits in internal organs in 54 per cent. of the cases of caries examined by him is a strong confirmation of this view. The lungs were most commonly affected. It is probable that in many of these the general infection was secondary to the disease of the bone, though it is quite possible that in many the reverse may have been the case. In some cases an injury serves as the starting point of the disease, the tubercle being deposited as a secondary complication.

Tubercle undergoes the same changes in bone as elsewhere; it excites inflammation in the tissues in which it is lying, varying in intensity with the general health of the patient and with the presence or absence of accessory sources of irritation, such as friction, or want of rest, or the presence of septic matter. The products of the tuberculous process tend to early degeneration and caseation, subsequently softening and giving rise to chronic suppuration or more rarely undergoing calcification. Many different terms are applied to tuberculous caries, according to these modifications of the process.

When the inflammatory new growth forms rapidly in the cancellous spaces, which thus soon become filled with vascular granulation-tissue containing numerous tubercle nodules scattered through it, before which the bony cancelli waste away and finally disappear, the disease is termed *fungating caries* or *caries fungosa.* This form is common in the short bones and in the epiphyses of long bones. If the morbid process reaches the cavity of a joint the fungating granulation-tissue sprouts into it, and spreads over the cartilages and synovial membrane, leading finally to complete destruction of the articulation (see Diseases of Joints). After reaching a certain degree of development, fatty degeneration sets in in the new tissue, and this is usually followed by softening and slow suppuration. When the bone is extensively destroyed, as is frequently seen in the vertebræ, without the formation of pus, the disease is termed *dry caries* or *caries sicca.* In dry caries the granulation-tissue may be partly absorbed and partly developed into new bone, if recovery takes place without the formation of pus at any stage of the disease. Thus in many cases of recovery from caries of the spine we find the whole body of a vertebra has disappeared, those above and below it having come in contact with each other and become firmly united by new bone (see Caries of the Spine). When suppuration takes place the process is usually slow, the result being the formation of a chronic abscess with thick, curdy pus, which gradually advances towards the surface. A large proportion of all chronic abscesses met with in surgical practice arise in this way. When the abscess opens on the surface, exposing the diseased bone to the air, the process is spoken of as *open caries.*

It frequently happens that caseation or chronic suppuration takes place before the cancellous bone has been completely destroyed in the rarefactive process. The unabsorbed fragments then being cut off from their nutrition perish, and we thus get the condition known as *caries necrotica* or *necrotic caries.* The fragments of dead bone may be of considerable size, forming large sequestra surrounded by carious bone, or may be so small as merely to give a gritty feel to the degenerated granulation-tissue in which they are lying. Tubercular caries very commonly assumes this form.

On examining a macerated specimen of bone from a case of tubercular caries it will be found to be much more porous and fragile than natural, the cancelli being thinned and the spaces enlarged. Here and there cavities will be seen where the cancelli have been completely destroyed and the spaces have coalesced. In these cavities loose pieces of dead bone may be lying. A fresh specimen shows the following appearances proceeding from the circumference to the centre of the carious patch. The earliest morbid change is increased vascularity of the medullary tissue, which is redder than natural; the next change observed is that the normal fatty or dark red semi-fluid marrow has become replaced by pink gelatinous granulation-tissue, and that the cancelli are becoming thinned. Nearer the centre the bony cancelli entirely disappear, and the new tissue becomes opaque and pale yellow from fatty degeneration. In the centre it may form a caseous mass, softening in parts into a thick, curdy, puriform fluid. Grey granulations are seldom to be recognized. If they are seen they are more likely to be found near the circumference where they have not yet been concealed by the further inflammatory changes around them. Caries necrotica presents the same appearances, with the addition of fragments of dead bone, mixed with the degenerating inflammatory products. If these are decomposing they will be black or grey in colour; if not, they are white. If the process have been very chronic, small patches of opaque white bone may be found, in which calcification has taken place in the inflammatory products filling the cancelli.

In simple or dry caries the same appearances are found, but there is not fatty degeneration. The granulation-tissue maintains its pink gelatinous appearance throughout.

Syphilitic Caries has already been described (see Syphilis, Vol. I., p. 1152). It affects most commonly the surface of bones and is then the result of a softening sub-periosteal gumma. The disease does not penetrate deeply, but leaves the surface rough and porous, and is accompanied by a good deal of inflammation of the soft parts around the affected bone. It occurs most frequently in adults and is very chronic. Like tubercular caries it is occasionally complicated by necrosis of smaller or larger fragments of the affected bone.

Caries is divided also into *superficial*, *central*, or *articular*, according to the part of the bone which it affects.

In all forms of caries in which suppuration takes place as soon as the resulting abscess is opened, decomposition of the discharges ensues, unless precautions be taken to prevent it, and the irritation caused by the contact of the septic matter with the diseased surface tends to perpetuate the chronic inflammation and cause extension of the destruction of the bone.

In all cases of caries the neighbouring periosteum is swollen and thickened and new bone is formed beneath it. In central caries the compact tissue is usually somewhat rarefied.

Situation of Caries.—Billroth and Menzel of Vienna have examined the question of the relative frequency of caries in different bones. In 1,996 cases the numbers were: skull, 161; facial bones, 44; vertebral column, 702; sternum, clavicle, and ribs, 184; bones of shoulder-joint, 28; elbow-joint, 93; wrist and hand, 41; pelvis, 80; hip-joint, 189; knee-joint, 238; ankle-joint and foot, 150; scapula, 4; humerus (shaft), 13; radius, 2; ulna, 4; femur (shaft), 31; tibia, 30; fibula, 2. A classification in regions gives: head and spine, 1091; upper limbs, 185; lower limbs, 720. Hence it appears that, while any bone may be affected with caries, it is most frequently met with in short and cancellous bones.

Symptoms.—The symptoms indicative of the occurrence of caries are very equivocal, and are not unfrequently, in the early stages, mistaken for those of ordinary abscess or rheumatism. They consist of pain in the bone, sometimes with a good deal of redness and swelling in the soft tissues covering it; abscess at last forms, often of considerable size; and, on letting out the pus, the character of the disease will be recognized, as the bare and rough bone may be felt with a probe, which sinks into depressions upon its surface, which though rough, yields readily to the pressure of the instrument. The cavity of the abscess gradually contracts, leaving fistulous openings, which discharge pus in varying amount. The discharge is frequently fetid, unless means be taken to prevent its decomposition. Granules of bone, the minute sequestra from necrotic caries, are often intermixed with it, and it has been shown to contain a considerable excess of phosphate of lime. The fistulous openings are generally surrounded or concealed by high spongy granulations, and the neighbouring skin is duskily inflamed.

These sinuses or fistulæ are often long and tortuous. They wind along and around the muscles, the pus finding its way along the lines of least resistance in the inter-muscular planes of areolar tissue, the external opening being often situated at a considerable distance, perhaps many inches, from the diseased bone. In these cases a long and flexible probe is required to traverse the sinuosities of the fistulous track so as to reach the bone at its extremity; and here Sayre's vertebrated probe (Fig. 508) is sometimes useful, being flexible and accommodating itself to the windings of the canal. A similar instrument has been devised also by Steele of Bristol.

The difficulty of draining these long sinuses often leads to the accumulation of septic pus, at a certain degree of pressure in the deeper parts, in consequence of which the suppuration may be maintained almost indefinitely, the patient finally perishing from exhaustion, hectic, chronic septic poisoning, or albuminoid degeneration of internal organs.

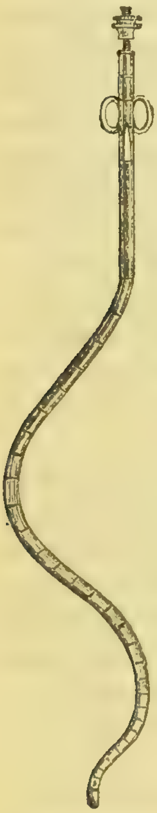


Fig. 508.—Sayre's Vertebrated Probe.

Treatment.—The treatment of caries will vary with its cause. In *simple caries*, the result of injury, recovery will usually take place if the part be put at perfect rest, as by fixing a diseased joint by means of a splint or by the application of a proper apparatus to a diseased spine, while at the same time the general health is maintained by attention to the ordinary rules of hygiene, change of air and a nutritious diet. Should there be an open wound strict attention must be paid to drainage, and to the prevention of decomposition in the discharges.

Syphilitic caries is usually readily cured by the ordinary treatment of syphilis, iodide of potassium being especially useful, and by the application of iodoform or iodide of starch ointment (see Syphilis, Vol. I.).

The treatment of *tubercular caries*, which, as before stated, is by far the most common form, must be conducted with reference to the constitutional condition which predisposes to it as well as by attention to the local disease. In many cases, especially in young subjects, perfect rest of the diseased part, combined with means calculated to improve the general health, will be sufficient to effect a cure. Hence it is well not to be in too great a hurry to interfere, by operative means, in caries of the small bones of children. I have often seen cases, especially of caries of the bones of the hands and feet, in which an operation for the removal of the diseased bone was apparently indispensable, recover spontaneously on change of air, and attention to the general health of the child; the disintegrated particles of the diseased bone being eliminated piecemeal.

In the earlier stages of caries, should there be any acute inflammatory symptoms, measures should be taken, by means of appropriate local and constitutional antiphlogistics, to subdue the activity and limit the extension of the disease; and when this has fallen into a chronic state, constitutional alteratives should be employed. Amongst these, cod-liver oil, the iodides, and change of air, more especially to the sea-side when the patient is young, should hold the first place. Counter-irritation is of little avail in these cases in arresting the progress of the disease. By means of blisters or iodine, thickening of the periosteum and of the soft structures covering the diseased patch of bone may be lessened, and pain subdued; but the real progress of the osseous disease cannot, I think, be influenced by such means when once it has passed the earliest stage.

When nature seems unable to eliminate the carious bone, all reparative action having ceased, or being inefficient for the restoration of the integrity of the part, an operation becomes necessary. Should there be any acute inflammation, either of the bone or of the surrounding tissues, any operative procedure should be delayed till this has been subdued, otherwise it may merely give a fresh impetus to the disease. Under all circumstances the strictest attention should be paid to the prevention of putrefaction in the discharges, lest septic osteomyelitis of the affected bone should follow the operation.

Operations.—The operations practised upon carious bones are of four kinds; consisting either in simple Removal of the Diseased Portion of Bone; in Excision of the Carious Articular End; in Resection of the whole of the Bone affected; or in Amputation of the Whole Limb.

Before proceeding to the *Removal of the Carious Portion of the Bone* the limb should be rendered bloodless by Esmarch's method, as the operator will then be able to see exactly what he is doing, instead of working in a deep hole filled with blood. The diseased portion of bone is then exposed by a suitable incision through the soft parts. The carious bone is best removed in most cases by means of a Volkmann's sharp spoon, or a gouge. As a rule, the gouge is only necessary to remove the superficial parts of the bone in central caries. For cleaning out the actual cavity the spoon is much better, as it is less likely to injure surrounding parts, and by using instruments of various shapes every part of the cavity may be cleaned in the same way as a dentist cleans a carious tooth. In some cases it may be necessary to use a small trephine to open up the cavity in the affected bone. I have found the *gouge-forceps* (Fig. 516) very useful in clearing away angular fragments and projections of bone. In some cases Marshall's *osteotrite* (Fig. 509) will be found a very serviceable instrument, clearing away the softened carious bone without risk to the surrounding healthy structures.

In removing carious bone with these instruments, the Surgeon may be sometimes at a loss to know when he has cut away enough. In this he may generally be guided by the difference in texture between the diseased and healthy bone ; the former cutting soft and gritty, readily yielding before the instrument, whilst the latter is hard and resistent ; so that, when all the disease is removed, the walls of the cavity left will be felt to be compact and smooth. In some cases, the healthy bone may have been softened by inflammation ; should there be any doubt as to the condition of what has been gouged out, the question may be settled by putting the detritus into water, when, if carious, it will become either white or black, whereas if healthy, but inflamed, it will preserve its red tint. In operating on young children especially, it is important not to use too much force, lest the inflamed, but otherwise healthy though somewhat softened bone, be cut away together with that affected by caries. After the operation the cavity must be carefully cleaned to remove any detritus or loose fragments that may be left behind. This is best done by means of pieces of sponge held in a pair of forcipressure forceps. The sponges should be moistened with chloride of zinc (gr. xl. to ℥j) so as to disinfect the wound thoroughly. All unhealthy granulation-tissue lining the sinuses should be scraped away with the sharp spoon. A few grains of iodoform may be introduced into the cavity and a small piece of green oiled silk may be put on the wound to prevent scabbing. Unless the wound is large it may be left open to heal by granulation. In large wounds a catgut stitch may be put in at each end. Drainage-tubes should be avoided if possible. The best dressing is iodoform or salicylic wool, applied so as to form a covering about an inch and a half to two inches thick over the wound, and extending at least six inches on each side of it. This may be changed at the end of a week for the purpose of removing the drainage-tube if one has been inserted. A similar dressing is then applied, and if the part affected is near a joint, a plaster-of-Paris bandage may be put over it and left on for a month or six weeks, unless some discharge shows out from beneath it, or the patient complains of pain, or suffers from febrile disturbance. A considerable number of cases have been treated in this way in University College Hospital with the best results. In a large proportion the wound has been found completely healed when the second dressing was removed. If the cavity be of very large size, more frequent dressings may be necessary. If the materials for this dressing are not at hand the wound may be dressed with carbolic oil, glycerine and carbolic acid, terebene and oil, or any other efficient antiseptic application.

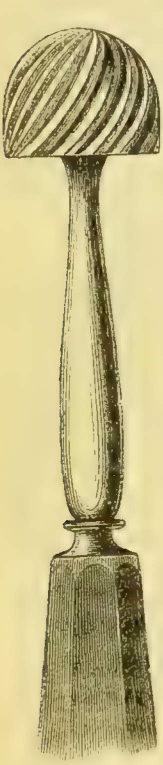


Fig. 509.—Marshall's Osteotrite.

Instead of removing the affected bone by means of instruments, Pollock has recommended that it should be dissolved by the application of a strong solution of sulphuric acid. The treatment is carried out as follows : the carious surface or cavity being exposed as before described, a solution of equal parts of strong sulphuric acid and water is applied by means of a glass brush or rod, and this may be repeated daily till the whole surface is quite free from diseased bone. In deep cavities a piece of lint soaked in a weaker solution (one part of the acid to five or six of water) may be stuffed in and left for two or three days. The slough resulting may in a day or two more be peeled of with forceps and the application repeated if any diseased bone can still be seen. The treatment is said to be efficacious, and the pain accompanying it is not severe.

When caries affects the articular ends of the bones, as those that enter into the formation of the elbow or shoulder-joints, it may be so situated as not to admit of removal in the way just indicated, but to require *Excision* of the diseased articulation: this operation we shall consider in a subsequent Chapter. When caries involves a bone so extensively that neither of the preceding plans can successfully be put into operation, it becomes necessary to perform either the *Resection* of the whole of the bone, if it be of small size, or *Amputation* of the limb, if of greater magnitude or if the neighbouring joints be extensively affected. Thus, for instance, resection of the os calcis may be required for caries of that bone; while, if the whole of the tarsus be affected, amputation is the only resource.

NECROSIS.

The transition from Caries to **Necrosis** is easy. Caries may be regarded as a condition closely analogous to ulceration of the soft tissues; whilst necrosis must be looked upon as identical with gangrene. Whilst caries, however, chiefly affects the cancellous structure, necrosis is met with in the compact tissue of bone, and occurs far more frequently in the shafts than in the articular ends of the long bones. It is, however, an error to suppose that the cancellous structure is exempt from necrosis; thus in the head of the tibia, or in the os calcis, small masses of necrosed bone are not unfrequently found lying in the interiors of carious or suppurating cavities. Different bones are affected by necrosis with varying degrees of frequency. The tibia at its anterior part is most frequently diseased; the femur in its lower third is also very commonly affected. The lower end of the humerus is not so often necrosed; but not uncommonly the phalanges of the fingers from whitlow, the skull from syphilis, the lower jaw from the emanations evolved in the manufacture of phosphorus matches, and the clavicle and ulna from injury or constitutional causes, are found affected by necrosis.

Causes.—The causes of necrosis are very various. We have just seen that it is *Predisposed* to by the structure of particular parts of bone, and is more frequent in some bones than in others. Among the constitutional conditions which predispose to it, we must rank in the first line scrofula and syphilis. Acute febrile disturbance, more particularly scarlet and typhoid fevers, are not unfrequent causes of necrosis in the young. Scarlet fever especially is apt to be followed by pains in the leg and about the knee, which at first appear to be of a rheumatic character, but which speedily run into abscess and are attended by all the symptoms of the most acute form of necrosis.

Most of the local conditions which give rise to necrosis of bone have been already described, and require merely to be mentioned here. Before the age of puberty almost all cases of extensive necrosis of the shafts of long bones are the result of acute diffuse periostitis or acute necrosis (see p. 281). In the cancellous tissue necrosis is sometimes the result of acute osteomyelitis, but more commonly arises from a more chronic form of inflammation, often tubercular, accompanied by caseation of the inflammatory products by which the vascular supply of the affected area is cut off. Acute osteomyelitis following injuries of bone is a common cause, especially after amputations (p. 267), or should the same condition arise without injury (p. 268), the same result takes place. Chronic periostitis and osteitis, when the disease assumes the osteoplastic form, may gradually lead to necrosis by obliteration of the Haversian canals (p. 266).

Sometimes the death of bone results from the extension of inflammation to it from the neighbouring tissues, as in some cases of whitlow, or from the destruction of its periosteum by a neighbouring abscess.

Syphilitic necrosis arises in three ways : first, from superficial ulceration extending till it reaches the bone and destroys its periosteum ; secondly, by the formation of sub-periosteal gummata, which finally soften and thus cut off a piece of bone from its vascular supply ; and thirdly, by gradual obliteration of the Haversian canals in chronic syphilitic osteitis.

In all these forms the immediate cause of the death of the bone is the arrest of the flow of blood through it.

In some cases necrosis occurs in old people without any evident cause, being then apparently simply the result of old age. This I have seen occur in the lower ends of the humerus and tibia, giving rise to rapid and usually fatal disorganization of the neighbouring joints, or to death from exhaustion after profuse suppuration. This *Senile Necrosis* may be looked upon as the counterpart in the bone of senile sloughing or gangrene in the soft parts.

Traumatic causes frequently give rise to necrosis. Thus the denudation of a bone, by stripping off of periosteum, may lead to its death ; but, though the bone thus injured often loses its vitality, yet, if the membrane be replaced, its life may be preserved, and even when the bone is exposed, adhesions may take place between it and the neighbouring soft parts, or granulations may be thrown out by its surface, which eventually form another periosteum. Necrosis frequently occurs as the result of the detachment and denudation of a portion of bone in cases of bad compound fracture ; so also the application of certain irritants, as the fumes of phosphorus, may occasion this disease, and hence it has been found that, in lucifer-match manufactories, necrosis of the lower jaw is a frequent consequence of the acrid fumes that are eliminated, gaining access to the bone through carious teeth.

Characters.—In whatever way it originates, necrosis may affect the outer laminæ only of the bone, when it may be called *peripheral ;* or the innermost layers that surround the medullary canal may perish, and then it may be termed *central ;* or the whole thickness of a shaft, or of the substance of a short bone, may lose its vitality, and it is then spoken of as *total.* The necrosed portion of bone, called the **Sequestrum,** presents peculiar characters, by which its nature may at once be recognized. It is of a dirty yellowish-white colour, and has a dull opaque look, and, after exposure to the air, it gradually becomes of a deep brown or black tint ; the margins are ragged, and more or less spiculated, and the free surface is tolerably smooth, but its attached surface is very irregular, rough, and uneven, presenting an eroded or worm-eaten appearance. This eroded appearance is very marked in sequestra that form in the interior of the terminal end of the femur in a thigh-stump after amputation, and is well illustrated by Fig. 28, where the lower smooth part is composed of the whole thickness of the bone, whilst the upper rough and spiculated portions consist of the central layers of bone separated from the outer layer, and hence their eroded external surface. When the sequestrum forms in the cancellous tissue, it is usually of a blackish-grey colour, and irregular or ovoid in shape.

When the necrosis has been the result of an acute inflammatory process, as osteomyelitis or infective periostitis, the bony tissue of which it is composed has exactly the appearance of a corresponding piece of healthy bone macerated after death. On the other hand, when the death of a piece of bone has been a complication arising during some chronic inflammatory process, the sequestrum bears evidence of the previous disease upon it. Thus, if it result from osteoplastic osteitis, it is denser than natural, if from rarefactive osteitis, as is commonly the case in necrosis of the cancellous tissue, it is lighter and more porous than the normal structure, and often eaten out into irregular cavities, or may present patches of calcification in the cancellous spaces.

Symptoms.—The symptoms of necrosis are divisible into three distinct periods. In the first they are those of the disease in consequence of which the death of the portion of bone has taken place, being acute in acute diffuse periostitis, osteomyelitis, chronic in chronic periostitis and osteitis, tubercular caries, or in syphilitic caries, periostitis or subperiosteal gummata. In the second period the primary disease having ceased, the process of separation of the dead bone from the living takes place with the formation of a suppurating layer of granulation-tissue at the expense of the latter, and simultaneously new bone is formed from the periosteum to maintain the rigidity of the part when the dead part becomes loose. In the third period, the sequestrum having been expelled or removed, the final processes of repair take place by which the restoration to the proper size and shape of the bone is effected. The particular character of the symptoms depends, however, not only on the stage and cause, but also in a great measure on the seat and the extent of the necrosis. As already stated, the sequestrum may be peripheral, central, or total, perhaps involving the whole thickness of the shaft.

The acute diseases causing necrosis have already been sufficiently described, but a few words are required on some of the chronic forms.

When the necrosis is associated with caries, as in caries necrotica, the symptoms are those already described as occurring in that disease, pain like that of rheumatism, and tenderness with gradual enlargement of the affected bone. At a later period chronic suppuration takes place, and the abscess at last points beneath the skin. When this is opened a probe will pass into the carious cavity in which the sequestrum is lying. When the sequestrum is small and central, it may become enclosed with a small quantity of cheesy pus in a dense wall of solid bone. The symptoms are then those of chronic abscess.

Extensive necrosis may occasionally take place without the formation of a drop of pus. Cases of this kind have been described by Sir James Paget under the name of *quiet necrosis*, and by Morrant Baker as *necrosis without suppuration*. The symptoms are those of chronic osteitis and periostitis (p. 273), and the diagnosis can be made only when, all means of treatment having failed, trephining of the bone is undertaken for the relief of the pain. In Baker's case the enlargement exactly resembled a tumour, and as spontaneous fracture finally took place, there seemed no doubt as to the nature of the disease. The real condition was discovered only after amputation at the hip-joint. In these cases the necrosis is due to arrest of the circulation by osteoplastic periostitis obliterating the Haversian canals, and the part necrosed is always the central portion of the compact tissue of the shaft.

Another course taken by necrosis, especially when it follows fevers, may be best illustrated by briefly describing three typical cases. The first was a girl aged 14, who complained of persistent pain in the buttock after an attack of rheumatic fever. A hard brawny swelling gradually formed during the following year. It was aspirated but nothing was found, and fears were entertained that it might be a sarcoma. Some weeks after a few drops of pus escaped from the puncture, and on dilating the opening a small sequestrum, about the size of a thumb-nail, was found detached from the side of the pelvis. The second was a man aged about 35, who complained of a slowly-growing tumour, about 2½ inches in diameter under the right nipple, that had appeared some months after typhoid fever. He was sent into University College Hospital by an accomplished practitioner as a case of scirrhus of the male breast. There was one small enlarged gland in the axilla, and there seemed no doubt about the diagnosis, but to avoid any possibility of error a deep incision was made into the growth, which grated under the knife, and felt and looked like scirrhus. It was accordingly removed, when a small cavity half an inch in diameter was found beneath, containing some caseating granulation-tissue; the finger passed from this through the pectoralis major to a small sequestrum on the fifth rib. The third case was a girl, aged about 14, who was sent into the hospital for a tumour, supposed to be an enchondroma, just below the crest of the ilium. On cutting down on it it proved to be a chronic abscess with exceedingly thick walls, containing a sequestrum about the size of a split pea which had been separated from the ilium. She had recently recovered from typhoid fever.

Separation of the Dead Bone and **Formation of Provisional New Bone.**—The separation of the dead bone, or its *Exfoliation*, is carried out by a process precisely similar to the mode in which a slough in soft tissues is thrown off, the only difference being the time required. Rarefying osteitis is set up in the living tissue where it meets the dead. The details of this process have already been described (Vol. I., p. 260). As the result of it a narrow zone of the living bone is destroyed, and its place occupied by soft vascular granulation-tissue. This process goes on most rapidly in the most vascular parts; thus we see the granulation-layer first completely formed near the periosteum and medullary canal, and gradually advancing from these points till the dead bone is completely separated from the living. If a bone in which a sequestrum is partly separated be macerated so as to destroy the granulation-tissue, a groove about one-twentieth to a quarter of an inch wide will be seen. On the living side of this the bone is porous and its Haversian canals enlarged and gradually coalescing. On the dead side the bone retains its normal compact structure. The line between the dead and living is always extremely irregular. The granulation-tissue in contact with the dead bone yields a more or less abundant supply of pus, which, according to B. Cooper, may contain as much as 2½ per cent. of phosphate of lime. When the separation is complete the dead bone lies closely surrounded by vascular granulation-tissue, and bathed in a certain quantity of pus. If the bone be decomposing and the discharge fetid, the pus will be increased in quantity in consequence of the irritation of the granulation-tissue by the septic products.

When once the dead bone has been detached by the formation of this line of separation, nature takes steps for its ultimate removal from the body. There is no evidence that it, in any circumstances, undergoes absorption to any appreciable extent; although, as Paget and Billroth remark, that portion which remains in contact with proliferating granulations may undergo a certain amount of diminution. That this may be so is rendered more probable by the fact that the ivory pegs used in the treatment of ununited fracture have been found to be partly absorbed after some weeks. The absorption of the margin of the living bone, in the formation of the line of separation, explains the fact that the sequestrum will always be found to be of much smaller size than the cavity in which it is lodged. The ultimate expulsion of the loosened sequestrum is effected by the growth of the granulations below it pushing it off the surface, or out of the cavity in which it lies. When the necrosed bone is *peripheral*, it will be readily thrown off in this way, although it may for a time be fixed and entangled amongst the granulations. When the sequestrum is *invaginated* within new or old bone, the process of elimination is necessarily very tardy, and may be difficult or impossible without surgical aid.

The *time* required for the separation of dead bone varies greatly. When it is superficial and small in size, a few weeks may suffice; but when the long or flat bones, as the femur, the scapula, or the ilium, are affected, the process may be extended over several years, and may terminate in the death of the patient from exhaustion before it is concluded; the constitution being harassed and worn out by hectic induced by profuse suppuration. Or the disease may fall into a chronic state, the limb becoming rigid, and the tissues much indurated, with fistulous apertures leading down to exposed but attached bone, and thus being a source of constant annoyance and suffering to the patient.

During the process of separation of a piece of dead bone and after the abscess first formed has burst, fistulous openings are left leading to the sequestrum through which pus is constantly discharged. The skin is unaltered in appearance, unless the sequestrum be seated in a superficial bone, when it is usually rigid and often red, smooth and shining. The soft parts surrounding the bone are always more or less indurated. The openings of sinuses leading to dead bone are usually surrounded by an elevated ring of granulation-tissue, often thinly covered by epithelium, the orifice presenting a peculiar appearance, which the older Surgeons compared to the cloacal aperture of a fowl.

Reparative Process.—The reparative process adopted by nature for the restoration of the integrity of the bone, a portion of which has necrosed, varies according to the extent of the loss of substance. When the outer lamellæ alone are necrosed, new bone is deposited by the surrounding periosteum, and the depression that has formed on the surface of the old bone is filled up by granulation-tissue, which ultimately ossifies. If the whole of the inner lamellæ of the shaft die, constituting *central necrosis*, the outer layers of bone become greatly consolidated and thickened by osseous matter deposited from the periosteum; in which, in the majority of cases, the circular or oval apertures termed *Cloacæ* are left for the escape of pus and the ultimate extrusion of the sequestrum (Fig. 510). In cases of "necrosis without suppuration" (p. 293), however, no cloacæ form, the dead bone continuing to be encased in the thickened outer layers. When the whole of a shaft dies, the reproduction takes place from various sources, principally from the periosteum, which is, indeed, essentially the organ of reproduction of bone; this becomes thickened and vascular. That the periosteum takes the principal share in the reproduction is evident from the fact that, where it is deficient or has been destroyed, apertures are left in the case of new bone; and if it be removed altogether, osseous tissue is either not formed at all, or most sparingly by the contiguous old bone, or by the epiphyses. The soft tissues, also, of the limb generally, if thick, as in the thigh, contribute to the formation of granulation-tissue, which gradually ossifies, and so tends to strengthen the new case; and, lastly, the articular ends of the old bone, still preserving their vitality, constitute most important agents in the reparative process, becoming consolidated firmly to the new shaft that is formed. The importance of the periosteum as the organ of regeneration of bone after the removal of the osseous structures, whether experimentally or surgically by resection, or by necrosis, has been conclusively demonstrated by Ollier of Lyons. This Surgeon has shown by many ingenious experiments, that in the lower animals reproduction of a whole bone may take place, as in the case of the radius in rabbits and pigeons, after it has been removed from within the periosteum; and that, if the periosteum be dissected off in slips, and twisted here and there between the muscles of the limb, new bone of various shapes may be formed on and by this partially detached membrane. Ollier has further shown that, although in man, after operations and disease, new bone may be formed by the contiguous osseous tissue, and even by the neighbouring soft parts, yet the periosteum is essentially the organ of the regeneration of bone; thus confirming, by new and ingenious experiments, and by additional observations, the views that have just been expressed. The whole of a necrosed bone may, after separation, be reproduced by the periosteum. This is admirably illustrated by the annexed drawing, taken from the photograph of a preparation in the museum of the late J. Wood of New York. The whole of the inferior maxilla had separated as the result of phosphorous disease; the patient, a girl, lived for three years, the lower jaw having been reproduced as a perfect ring of bone, as represented in Fig. 511.

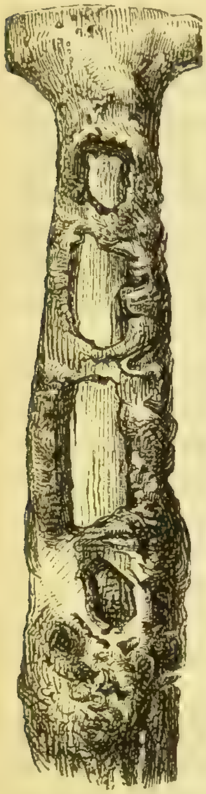


Fig. 510. — Central Necrosis. New Bone with Cloacæ; included Sequestrum.

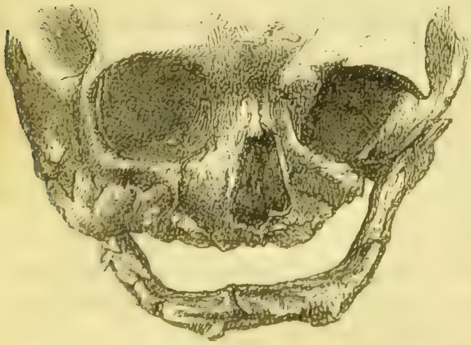


Fig. 511.—Reproduction of Lower Jaw after Phosphorus-Necrosis.

Thus it will be seen that the new bone is formed by the vascular and healthy tissues generally that surround the seat of disease, though in this reparative process the periosteum takes the chief share, the epiphyses and old bone the next, and the areolar tissue of the limb a very secondary part if any. In acute necrosis, repair commences as soon as the intensity of the inflammation has been reduced by the escape of pus through the incisions. In a few days the swollen and thickened periosteum will be found to be lined with scales of new bone, the first step towards the reproduction of the shaft.

The new bone deposited on those parts of the surface of the shaft from which a scale of the old osseous tissue has been separated, or enveloping the sequestrum when the whole thickness of the shaft becomes necrosed, is at first rough, porous, cancellated, and very vascular; after a time it gradually becomes harder and more compact. The case of new bone, which necessarily exceeds in circumference the old bone, as this is included within it, gradually contracts both in texture and in size, becoming firmer and smaller after the removal of the sequestrum; and, the cloacæ closing as soon as all dead bone has been extruded, it eventually acquires the proper size and shape of the bone; the medullary canal even becoming more or less perfectly restored. In this way, restoration of the whole of the shaft of many of the long bones, such as those of the arm, forearm, and leg, will take place, provided always the epiphyses have been left untouched by disease. If one or other of these have been destroyed, all power of repair seems to be lost.

The new bone usually forms with such rapidity that the shell surrounding the sequestrum, or the *involucrum* as it is termed, is sufficiently strong to support the limb by the time the dead bone is loose.

In cases of acute necrosis, in which amputation has been performed but a few weeks after the setting in of the disease, a thick layer of new bone will sometimes be found under the periosteum; but in some instances, when the whole of a shaft is necrosed, the new case is not completed, or has not become attached to the articular ends before these are separated from the shaft. In other cases, though complete, it has not sufficient strength to resist the contractions of the muscles of the limb; under these circumstances, it may spontaneously fracture—an accident that I have seen happen both in the femur and the tibia—or may become shortened or bent. In other instances, again, when the periosteum has been lost by sloughing, new bone does not form (Fig. 512); but, as the sequestrum separates, the limb becomes shortened, loose, deformed, and useless.

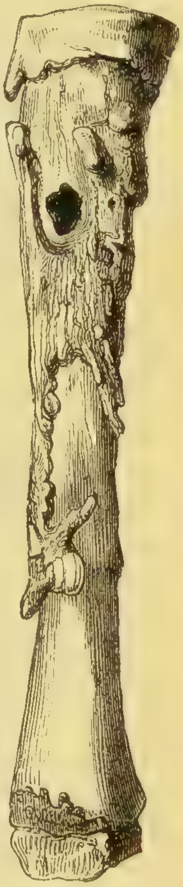


Fig. 512. – Acute Necrosis of shaft. Deficient Formation of New Bone.

Treatment.—In the treatment of necrosis, the indications to be accomplished are sufficiently simple, though the mode in which they have to be carried out often requires much patience and skill on the part of the Surgeon. In those cases in which the bone is perishing from some chronic progressive disease, as chronic osteitis and periostitis with obliteration of the Haversian canals, or when it is associated with caries, the first point is to remove, if possible, any constitutional or local condition which tends to keep up the disease. Thus, for instance, if it appear to be the result of scrofula or syphilis, those conditions must be corrected. So, again, if it arise in the lower jaw from the fumes of phosphorus, the patient must necessarily be removed from their influence. If it be threatened in consequence of denudation of bone, the best mode of prevention will be to lay down flaps of integument and so to cover the exposed surface. Abscesses should be opened as soon as recognized. In cases of acute infective periostitis the extent of the necrosis is very materially limited by free and early incisions and the use of antiseptics, and in this way the separation of the epiphyses can often be prevented, and the danger of death from exhaustion or pyæmia avoided.

Removal of the Sequestrum.—When all that is possible has been done to arrest the morbid condition to which the necrosis is due, the separation of the sequestrum should be left as much as possible to the unaided efforts of nature. The less the Surgeon interferes with this part of the process the better; for, as has justly been observed by Wedemeyer, the boundaries of the necrosis are known to Nature only, and the Surgeon will most probably either not reach, or he will pass altogether beyond them. Here much patience will be required for many weeks or months; and the utmost the Surgeon can do is to attend to the state of the patient's health, treating him carefully upon general principles, removing inflammatory mischief by appropriate means, opening abscesses as they form in the limb, limiting or preventing the decomposition of the discharges by antiseptic applications, and at a later period, supporting the patient's strength by good diet, tonics, and general treatment, calculated to bear him up against the depressing and wasting influence of continued suppuration, and of the irritation induced by the disease.

As soon as a sequestrum has been detached from the adjacent or underlying bone the Surgeon must proceed to its removal. In most cases it is sufficiently easy, when the necrosis is superficial, to ascertain that this separation has taken place, as the flat end of a probe may be pushed under the edge of the detached lamina. When, however, the sequestrum is deeply seated, it is not always so easy to be sure that the separation has occurred; though, in the majority of cases, the introduction of a probe through one of the fistulous openings leading to the necrosed bone, and firm pressure exercised upon this, will enable the Surgeon to detect that degree of mobility which is characteristic of looseness. In other cases, however, the sequestrum, though complelely free from all osseous connections, still continues to be fixed by the pressure of the surrounding granulations, and by the extension of its spicula into the corresponding cavities of the new osseous case. This especially happens when the sequestrum is central and invaginated, and the cloacæ leading to it are so small that but a limited portion of it is exposed. Here a more careful examination will be required; and its looseness may sometimes be determined by pressing upon it with a probe in a kind of jerking manner, or by introducing two probes through different cloacæ, at some distance from one another, and alternately bearing upon the exposed bone with one or other of them. Then, again, if the sound elicited by striking the end of the probe against the sequestrum be a peculiarly hollow one, the detachment of the bone may be suspected. The duration of the disease, also, will probably throw some light upon the probable state of things inside the new case.

The separation of the sequestrum having been ascertained, the Surgeon must adopt measures for its extraction. The part should first be rendered bloodless by Esmarch's apparatus if the disease is situated in a limb. If the necrosis be *peripheral*, all that is necessary is to make an incision down to it through the soft parts, either by directly cutting upon it or by slitting up sinuses with a probe-pointed bistoury, and then to remove it with a pair of forceps, or to tilt it off the bed of granulations on which it is lying, by introducing the end of an elevator beneath its edge.

When the necrosis is *central*, the sequestrum being embedded in a new case or covered in by old bone, the operative procedures for its removal are of a more complicated character. The difficulties here consist in some cases in the depth from the surface, and in the obstacle offered to its passage by the soft parts; in others, in the length and magnitude of the sequestrum in proportion to the small size of the cloacæ, and in the manner in which it lies in a direction parallel to these openings. In cutting down upon the bone, the Surgeon must be guided by the direction and the course of the fistulous tracks that lead to the principal apertures in the new case, the incision being placed in the axis of the limb, and carefully directed away from the large blood-vessels and nerves. If the part has not been rendered bloodless, however, the hæmorrhage is somewhat abundant, in consequence of the injected state of the tissues furnishing a copious supply of blood, and their rigid condition preventing retraction of the vessels; this, however, may be arrested by a tourniquet, or by the pressure of an assistant's fingers, and will soon gradually cease of itself. The bone having been freely exposed, it will sometimes be found that the

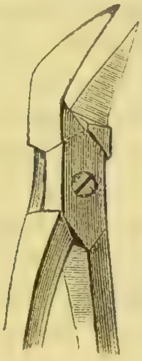


Fig. 513.

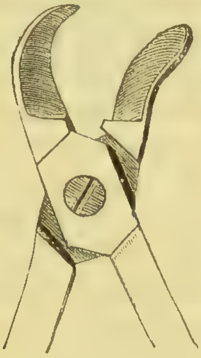


Fig. 514.

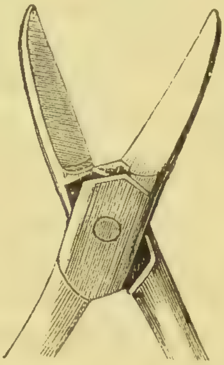


Fig. 515.

Cutting Pliers for removing Necrosed Bone.

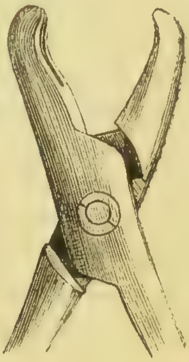


Fig. 516.
Gouge-forceps.

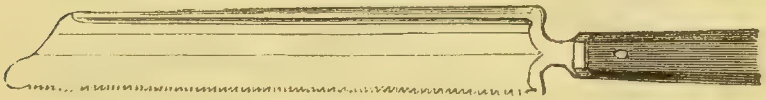


Fig. 517.—Straight Saw for removing Necrosed Bone.

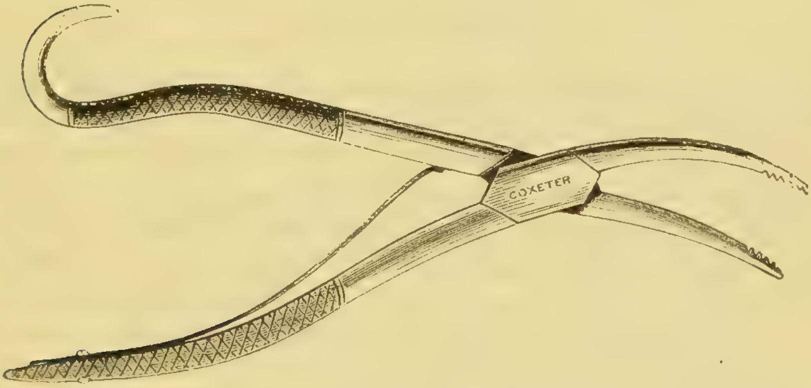


Fig. 518.—Necrosis-Forceps.

cloacæ are of sufficient size to allow the ready extraction of the sequestrum. But in the majority of cases, this cannot be done at once, and the apertures must be enlarged, either with the chisel or the trephine, according to the density of the new case, and the amount of room required. Occasionally when two cloacæ are close to one another, the intervening bridge of bone may very conveniently be removed by means of cutting pliers, of different shapes (as in Figs. 513, 514, and 515), or by means of a Hey's or a straight narrow saw having a movable back to stiffen the blade (Fig. 517), and space thus given for the extraction of the sequestrum. Very convenient pliers for this purpose are those represented in Fig. 516. They are made with gouge ends, and hence may be termed *gouge-forceps*. I have found them extremely serviceable in many operations upon the bones. Care, however, should be taken not to remove more of the new case than is absoutely necessary, lest the ultimate soundness of the limb be endangered. In necrosis of the lower end of the femur the bone surrounding the sequestrum is often so peculiarly dense that it can be cut away so as to expose the dead bone only by the means of a chisel and mallet, used with considerable force. For the extraction of the sequestrum, the most convenient instrument is a pair of strong necrosis-forceps, well roughened at their extremity, and straight or bent as the case may require (Fig. 518). Occasionally the sequestrum is so shaped and placed that it cannot be seized with this instrument; in these circumstances it will be useful to drive a screw-probe (Fig. 113) into it, by which it may either be extracted, or so fixed as to admit of seizure and removal by the forceps. In some cases, additional and convenient purchase may be obtained, by fixing a bone-forceps, such as is represented in Fig. 519, firmly into the dead bone. If the sequestrum be too large to be removed entire through the cloacæ, it may perhaps best be extracted piecemeal, having been previously divided by passing the points of narrow but strong cutting-pliers into the interior of the bone.

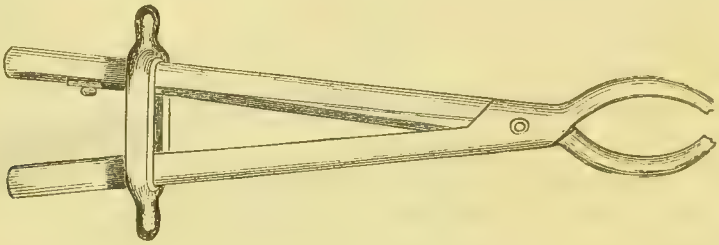


Fig. 519.—Bone-Forceps.

After the removal of the sequestrum, a smooth hollow cavity will be left in the new case, from the bottom and sides of which blood usually wells up freely, issuing abundantly from the vascular bone, and from the granulations lining its interior. Should this hæmorrhage be at all troublesome, elevation of the limb and pressure will always arrest it without difficulty. In the subsequent treatment the chief trouble arises from the accumulation of discharges in the cavity from which the bone has been removed, where they are prone to become excessively foul. To prevent this the cavity should be washed out with chloride of zinc solution (gr. xl. to ℥j.) immediately after the operation, and some crystalline iodoform sprinkled in it. It may then be dressed with salicylic or iodoform wool. In this way it can often very soon be brought into a condition to require dressing only about once a week. If these dressings are not at hand, carbolic oil, terebene and oil, or glycerine and carbolic acid, may be applied, and the wound well syringed with Condy's fluid. If the sequestrum have been a long one, and have involved the greater part of the shaft of the bone, it may happen that the new case has not sufficient strength to maintain the limb of its proper length and shape, and that it will bend or break under the action of the forces and weight to which it is subjected. In order to prevent this accident, it will be necessary to put it up in light splints, or in a starched bandage. After the removal of the dead bone, the sinuses will speedily close, and the limb eventually regain its normal size and shape.

Amputation.—If the necrosed bone be so situated that it cannot be removed, occupying too great an extent and continuing to be firmly fixed; and if at the same time the patient's health have been worn down by constant discharge, and symptoms of hectic come on; or if the limb have generally been greatly disorganized by the morbid processes going on in it, recourse must be had to amputation as a last resource. It is especially in the lower third of the thigh-bone that these severe forms of necrosis occur, necessitating amputation of the limb. When necrosis affects the flat posterior surface of this bone above the condyles, a special source of danger occurs in the possibility of the sequestrum causing ulceration or wound of the popliteal artery. In cases of this kind, suddenly fatal hæmorrhage might occur. Should the hæmorrhage, though abundant, not be fatal, what course should the Surgeon adopt in such cases? Should he attempt to ligature the vessel, or should he amputate the limb? The line of practice must, I think, be determined by the condition of the limb itself and by the state of the patient's health. If these be both tolerably good, the limb not too much disorganized, and the powers of the system not too much reduced by hectic, an attempt might be made, by slitting up the sinuses, to expose and secure the popliteal artery at the seat of injury in it, and, by ligaturing it, to save life and limb. But should this attempt fail, as I have known happen, or should it not be thought prudent to make it, owing to the low state of the patient's strength, or the disorganized condition of the limb, amputation must be done without delay. As an idiopathic disease, necrosis of the tibia requiring amputation is rarely met with; but when it is the result of bad compound fractures, or of other serious injuries, removal of the limb may become imperative. In acute necrosis of the lower end of the thigh, or of the shaft of the tibia involving the contiguous joints, and attended by deep and extensive abscess of the limb, amputation is imperative.

Resection of the whole of the necrosed bone may be advantageously performed in such cases as those of the metacarpal and metatarsal bones, or in those of the forearm or leg, where sufficient stability of limb is secured by the remaining bone or bones to leave a useful member. The diseased bone may be thus removed in necrosis of the ungual phalanx occurring from whitlow, where, by the excision of the dead bone, the end of the finger may be preserved: also in necrosis of some of the metatarsal and tarsal bones, or those of the forearm, and the fibula. Subperiosteal resection in cases of acute necrosis has been already alluded to (p. 284).

The remarks that I have hitherto made apply chiefly to necrosis of the long bones of the extremities. As there are a few special considerations connected with necrosis of the flat bones, we will now consider these briefly.

Necrosis of the Sternum, Scapula, or Bones of the Pelvis, is an excessively tedious process, there being but very little tendency to the formation of a line of separation and to the detachment of the sequestrum, which will continue bare, rough, and adherent for many years. Should it be so situated that it can be removed, it must be excised, even though not detached. When the ilium and pelvic bones are affected independently of the hip-joint, it is seldom that any operative measure can be employed with advantage ; here we must leave the patient to the chance of the bone being at length so loosened as to admit of extraction. In some cases, however, if the disease be limited to a portion of the crest of the ilium, or to the tuber ischii, the dead bone may be removed ; although in these instances it not uncommonly happens that disease of a similar kind exists elsewhere about the sacrum or spine, that will eventually destroy the patient. In a case in which I removed a portion of the crista ilii for necrosis that was apparently confined to that bone, it was found, on the patient dying some weeks afterwards of erysipelas, that the lumbar vertebræ were also diseased. Of late years, considerable portions of the pelvis have been successfully excised for necrosis, as will be more fully mentioned when I come to speak of excision of the hip-joint. The tuber ischii, when affected, may readily be extirpated.

Necrosis of the Cranial Bones is of frequent occurrence as the result of struma or syphilis, or the two conditions conjoined. When met with in children, it is usually strumous, often occurring after measles or scarlet fever : in adults it is usually syphilitic, though by no means invariably so, being sometimes the result of blows in people of otherwise healthy constitution. There are four situations in which necrosis of the cranial bones may occur, viz., in the vault of the skull, the frontal bone, the temporal bone, or in the sphenoid and ethmoid bones. When idiopathic necrosis affects the vault, it is usually syphilitic ; when it occurs in the other situations, especially in the temporal bone, it is commonly strumous.

Three forms of necrosis affect the cranial bones. In one case, the outer table is alone affected ; this perishes, separates, and exfoliates, granulations spring up from the outer surface of the inner table, and a process of repair is thus established. In the second form of the disease, the whole thickness of the skull necroses, separates from the dura mater and surrounding healthy bone in the usual way, and may be detached in large irregularly-shaped pieces, sometimes of large size, occupying several square inches. In the third form, the necrosis is hard, dry, rough, and pitted and worm-eaten, penetrating through the diploë to the inner table, separating very slowly, and lasting an indefinite period.

Results.—In necrosis of the cranial bones, there is always the special danger of extension of inflammation to the membranes of the brain, and the consequent occurrence of effusion within the skull, leading to convulsions, coma, and death. This danger is greatest when the petrous portion of the temporal bone is affected, as the dura mater is continued into some of the canals by which it is perforated. Cerebral complication is less likely to occur when the frontal bone is the seat of disease, more particularly the lower part of this bone, where, by the intervention of the frontal sinuses, the anterior wall is altogether carried away from the inner table, and from all dangerous proximity to the membranes of the brain.

The *Signs* of necrosis of the cranial bones are very obvious. When the vault or forehead is affected, there is tenderness, with some puffiness, and gradual elevation of the scalp into an abscess. When this is opened, the necrosed bone may be felt or seen lying, bare, at the bottom of a sinus or unhealed ulcer. When the petrous portion of the temporal bone is the seat of disease, there will have been ear-ache, followed by profuse fetid discharge from the ear; it is usually secondary to chronic inflammation of the middle ear with perforation of the tympanum, escape of the ossicula auditûs, and deafness. When the sphenoid or the ethmoid is affected, deep pains in the head, persistent œdema of the eyelids, and fetid discharge from the nose, will reveal the nature and seat of the mischief.

The *Treatment* of necrosis of the cranial bones will vary according to the nature and the seat of the disease. In the dry pitted variety, exposing and scraping the diseased osseous surface, or the application of a strong solution of sulphuric acid will often bring about a healthy action, provided the disease have not penetrated too deeply. Should there be reason to think that the inner table has been perforated, it will probably be safer to leave the case to the reparative processes of nature than to trephine. If, however, the anterior wall of the frontal sinus be the seat of the disease, or if the supraorbital ridge be affected, the dry and rough bone may be safely removed, as I have twice had to do, by the application of the trephine in the first instance, and of the gouge in the other case. When exfoliating necrosis of the outer table, or of the whole thickness of the bone, affects the vault of the skull, the loosened plate may readily be lifted off its granulating bed by means of the elevator or forceps, after it has been fairly exposed.

Necrosis of the petrous portion of the temporal bone may be looked upon as an incurable disease, which is usually fatal from septic meningitis. When the sphenoid or ethmoid is the seat of necrosis, little can usually be done by operative interference; though in the latter case portions of sequestrum may sometimes be extracted through the nostrils, and in one extraordinary case under my care in University College Hospital, I removed through the mouth the whole body of the sphenoid bone. The patient, a man aged forty-three, had suffered from syphilis for fifteen years, and from disease of the bones of the nose and upper jaw for three years. The anterior part of the hard palate was destroyed, and it was through the fissure so formed that I removed the bone. The fragment included the sella Turcica, and the roots of the pterygoid processes, but the clinoid processes could not be recognised. The patient had suffered from no cerebral symptoms except occasional headache and some loss of memory. He made a good recovery.

The **Patella** is rarely necrosed. I have, however, met with two instances of primary necrosis of this bone. One case occurred in an elderly woman. The disease came on without any evident external cause, commencing in the anterior part of the patella and gradually implicating the bone, until it became perforated, when rapid suppurative disorganization of the knee-joint ensued, necessitating amputation. The other case occurred after simple fracture of the patella, in a man, and is described at p. 638, Vol. I.

Ribs.—When the ribs are necrosed, abscesses and sinuses will often form to a considerable extent on the side of the chest. These must be laid open, and the diseased portion of bone scraped away by the gouge. In doing this, care must of course be taken that the adjacent intercostal space be not punctured by an unfortunate slip of the instrument—an accident that is best avoided by protecting the gouge well with the finger.

CHAPTER XLVII.

STRUCTURAL CHANGES IN BONE AND TUMOURS OF BONE.

HYPERTROPHY OF BONE.

True Hypertrophy of Bone, that is to say, increase in size without alteration in form or structure, is very rare. It occurs as the result of excessive use, in common with the enlargement of the muscles inserted into it.

The term **Inflammatory Hypertrophy** is often applied to those chronic inflammatory processes which cause enlargement of a bone, diffused over a considerable part of its length. When the thickened bone is more spongy than natural, the change is termed *Spongy Hypertrophy ;* when it is denser, *sclerosis,* or hardening of bone. Spongy hypertrophy occurs in its most marked form in the disease described by Sir James Paget as osteitis deformans (p. 312). Sclerosis is most commonly met with as the result of syphilis or after recovery from chronic osteitis and periostitis in scrofulous subjects. It may affect several bones at the same time ; and, in the long bones, may lead to filling up of the medullary and Haversian canals with bony substance, with some thickening of the bone generally. This condition is not recognizable with certainty during life.

Increase of Length of Bones.—Allusion has already been made at p. 273 to the hypertrophy of bone which sometimes follows chronic osteitis. This increased growth of bone, as a result of morbid conditions, has been investigated by Stanley and Paget in this country, and by Langenbeck and others on the Continent. It has been observed in connection with necrosis, chronic osteitis, and chronic abscess ; and also with chronic hyperæmia of the soft parts of a limb. Langenbeck, from his observations, concludes that morbid changes which give rise to irritation and hyperæmia of the osseous tissue lead, as long as the growth of bone continues, to an increase both in length and in thickness ; and that the increase of growth in length affects especially the diseased bones, but may also occur in a healthy bone of the same limb. Sometimes, as Paget has pointed out, the long existence of an ulcer of the integuments in a young person may produce thickening and elongation of the bone. When the femur undergoes elongation in this way, the inequality in length of the limb, unless the opposite limb be lengthened by artificial means, may lead to talipes of the foot of the lengthened limb or to lateral curvature of the spine. The tibia sometimes becomes elongated, while the fibula remains of its normal length ; and in such cases the former bone becomes curved. The diagnosis of this condition from the curvature of rickets consists, according to Paget, in the marked elongation ; in the absence of thickening of the ends of the bone, which are usually even more nearly equal in size to the shaft than in the natural state, on account of the thickening of the latter ; and especially in the fact that "the rickety tibia is compressed, usually curved inwards, its shaft is flattened laterally, and its margins are narrow and spinous ; while, in the elongated tibia, the curve is usually directed forwards, the margins are broad and round, the surfaces are convex, and the compression or flattening, if there be any, is from before backwards."

ATROPHY OF BONE.—This term comprises two conditions : one in which the bone is wasted, and another in which an arrest of growth occurs.

Atrophy occurs, as a natural result, in old age ; the change that takes place in the lower jaw being a familiar example. In other cases it is said to happen as a consequence of fracture ; the nutrient artery of the bone having been torn across, and one of the fragments consequently receiving insufficient vascular supply. Atrophy of bone commonly occurs also from disuse, as is the case in old dislocations. In atrophy, the bone becomes thinner, lighter, and more porous than natural ; the compact structure disappearing until a mere paper-like layer may be left, and the cancellous becoming expanded, the spaces being filled with soft yellow fat. Atrophy of bones is common in general paralysis of the insane. It is often especially marked in the ribs, and is a common cause of fractures, occurring either spontaneously or during the restraint necessarily employed during a maniacal outbreak.

Arrested Growth of bones is an occasional consequence of disease. Its occurrence in rickets will be presently referred to. It may be a result of disease of the epiphyses and joints, or of the resection of the epiphyses in children, and may follow the formation of cicatrices after burns in the neighbourhood of joints. The effect of paralysis on the growth of bone varies according to the extent of the loss of nerve-power. It is common to see normal growth of the bones in limbs affected with infantile paralysis, in which the muscles are wasted ; while in other cases it is materially impaired.

RICKETS.

RICKETS is a general disease, the most important manifestation of which is an imperfect development of the new tissue of growing bones. It occurs only in early childhood, most frequently appearing during the first or second year of life, though it has been observed as late as the ninth year, and is said occasionally to be congenital.

Causes.—Want of sufficient food and of fresh air, want of cleanliness and light, and all the unhealthy surroundings of the overcrowded poor of a large city, are the great causes of rickets. It is rarely met with amongst the wealthy classes, and in the country it is scarcely seen, even among the poor. Insufficient or improper food is undoubtedly the most important of the more special causes of rickets. There is but one proper food for a child during the first nine months of its life, and that is the milk of a healthy woman. The ill-fed mothers amongst the working classes, exhausted as they often are by repeated child-bearing and unnaturally prolonged lactation, are very frequently unable to supply milk of a sufficiently nutritive quality, and thus, even when suckled the child is but half-fed. Should it be brought up by hand, in order to save expense, flour, or various useless patent preparations of starch, are largely used in place of cow's milk. This early feeding with starch before the child is capable of digesting it, is probably the most fruitful cause of rickets. Even if there be no error in feeding, there is reason to believe that the offspring of feeble mothers tend to become rickety. The health of the father has not been shown to exert any influence. Parrot has lately maintained that syphilis in the parents may cause rickets in the child, but against this there is, as Sir William Jenner has pointed out, one unanswerable argument; in a family of rickety children, as a rule, the younger members are most affected, while in inherited syphilis it is exactly the reverse. Tubercle and scrofula have no definite connection with rickets, in fact, they are seldom met with in the same subject. A deficiency of lime in the water of the district has also been stated to be a cause of this disease, but this is evidently not the case, for rickets is far more common in London, which is supplied with water containing a considerable amount of lime, than in Glasgow where the water contains merely a trace.

Symptoms.—These may be divided into general symptoms and those referable to the changes in the bones. The *general symptoms* are the following: the child may be thin, but is more often apparently well nourished, sometimes very fat. Its mucous membranes are pale, but the cheeks are often redder than natural. On careful examination, however, with a lens, this will be seen to be caused by a network of dilated capillaries in the true skin. A most characteristic sign is profuse sweating of the forehead when the child is asleep, the rest of the body often being at the same time hot and dry, though the thermometer rarely shows any marked elevation of temperature. There is often general tenderness of the body, so that any handling is painful; partly in consequence of this and partly from the heat of the body, the child kicks off its bed-clothes at night, so that it is sometimes impossible to keep it covered, unless it is made to sleep in flannel drawers and a jersey. The digestion is often good, but there is a tendency to attacks of gastric catarrh, with a furred white tongue and perhaps vomiting. The motions are clay-coloured and offensive. Flatulence is common, and owing to the weakness of the muscles, which is often a marked effect of rickets, the child usually becomes pot-bellied. The spleen is frequently enlarged, and in some cases, the liver also. The urine presents, as a rule, nothing characteristic. It may contain an excess of phosphate of lime, but this is not the result of softening of the bones, but evidence of imperfect assimilation.

The *changes observed in the bones* appear early in the disease. They consist of enlargement of the articular ends, most marked at the points of junction of the shaft with the epiphyses; in consequence of which the joints appear to be swollen. The enlargement is also especially marked at the junctions of the ribs with their cartilages, which form prominent rounded swellings, felt and sometimes clearly seen through the skin, giving rise to the appearance which has been termed the "rickety rosary." At a later period, owing to the softness of their structure, the bones bend, giving rise to various characteristic deformities. Humphry and Langenbeck have called attention to the want of growth in length often observed in rickets. Humphry says that the humerus and femur are about one-fourth shorter in rickety subjects than in healthy individuals of the same age. The most important deformities arising in different parts are the following:—The *head* early appears large, the forehead being especially protuberant, and the face small. The fontanelles, especially the anterior, are very slow in closing; the bones of the skull may be thickened, forming prominent ridges on each side of the sutures, though occasionally in the occipital region they are unduly thin. The *spine* in young children usually presents one long curve backwards from the lower cervical region to the coccyx, with a compensating curve forwards in the neck. In older children there may be merely exaggeration of the normal curves. The *chest* presents very characteristic deformities ; the sternum projects somewhat forwards, with a deep depression on each side caused by the sinking-in of the soft newly-formed part of the ribs at their anterior extremities. The deformity is commonly termed "pigeon-breast." The depression is less on the left side, as the ribs are supported by the heart. The lower ribs are pushed outwards by the abdominal viscera. The angles of the ribs are less obtuse than natural. The *clavicles* show merely an increase of the normal curves. The *humerus* is usually bent outwards at the insertion of the deltoid ; the *bones of the forearm* are bent outwards in the lower third. The *pelvis* is narrowed from before backwards, more especially if the deformity commences before the child has learned to walk. The *femur* presents a single long curve forwards. The *tibia* and *fibula* are bent forwards and outwards or forwards only in their lower thirds. The deformities here mentioned are the most common, but other varieties may be met with. As the child becomes older it frequently becomes knock-kneed or bow-legged.

Dentition is usually much delayed. This is an important symptom, and it is, therefore, necessary to remember the dates at which the teeth should appear. This may be easily done by the following formula, which is accurate enough for clinical purposes. Taking the teeth in anatomical order, commencing with the central incisor, they appear at the following dates in months, 7, 9, 18, 12, 24.

Progress and **Prognosis.**—Under proper treatment rickets can usually be cured. The bones then rapidly become solid and firm, and remain permanently fixed in their abnormal shape. The concavities of the curves become partly filled up to give the bone the necessary strength, while absorption takes place laterally to preserve lightness. This is often very marked in the femur, the antero-posterior diameter of which may be double the transverse. After recovery from rickets there is frequently early union of the epiphyses, by which the whole body is stunted. Muscular development is, however, often good, and the patient may eventually become sufficiently powerful.

Rickets infinitely rarely causes death directly, but by impairing the power of coughing it indirectly causes the fatal result in a considerable proportion of cases of bronchitis in children.

Pathology.—Beyond the fact that the red corpuscles have been found deficient in number, examination of the blood has thrown but little light on the disease. The nature of the enlargements of the liver and spleen are somewhat doubtful and require further investigation.

In the bones the essential features of the morbid process are, first, an exaggeration of the processes immediately preparatory to the development of true bone ; secondly, an imperfect conversion of this preparatory tissue into true bone ; and thirdly, a great irregularity of the whole process. In rickets there is a growth of soft bone, but no softening of healthy bone. Such osseous tissue as has been developed before the disease commenced remains unchanged, unless absorbed in the process of the formation of the medullary canal. The pathological appearances are best studied on a longitudinal section of a long bone. In normal ossification a thin bluish line is seen between the unaltered cartilage and the newly-formed bone; in this the proliferation of the cartilage-corpuscles is taking place preliminary to the formation of bone. In rickets this line is much thicker than natural, and irregular processes project from it into the cartilage of the epiphyses. The process is wanting in the regularity observed in normal ossification. The proliferating cartilage-cells are heaped irregularly together, and patches in which calcification of the matrix is taking place, are met with, scattered here and there. The vascular medullary spaces also which normally penetrate in an even line into the proliferating layer of cartilage show the same want of regularity in their development. Some will be found projecting an eighth of an inch or more in advance of the others into the unaltered cartilage. These spaces are lined, as in normal bone, with osteoblasts, and bone is formed from them, but the osseous tissue thus produced is softer than natural, and cartilage-cells unaltered, or merely calcified, may be found embedded in it. Beneath the periosteum, especially at the line of junction of the epiphyses with the shaft, a thick layer of reddish, vascular, spongy bone is found. Microscopic examination shows that the osteoblastic layer beneath the periosteum is greatly increased in thickness; the osteoblasts are numerous, but the osteogenic fibres between them are imperfectly developed, and lime salts are but scantily deposited; the resulting structure is therefore softer than natural.

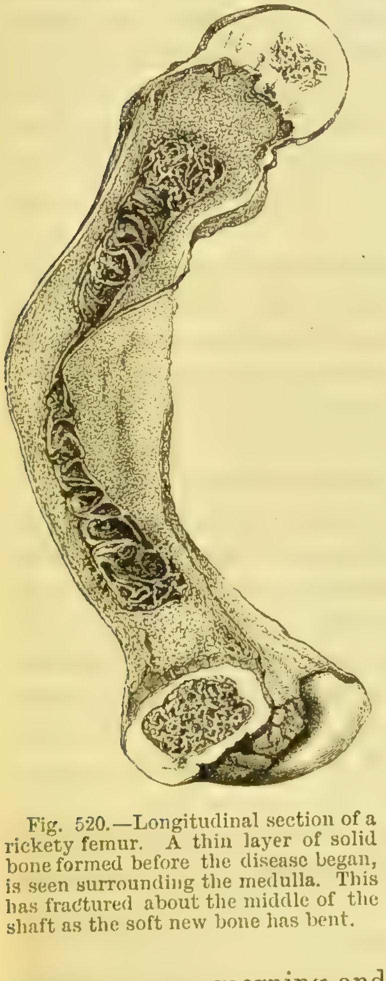


Fig. 520.—Longitudinal section of a rickety femur. A thin layer of solid bone formed before the disease began, is seen surrounding the medulla. This has fractured about the middle of the shaft as the soft new bone has bent.

Treatment.—In the treatment of rickets our first endeavour must be to remove those conditions which are known to cause the disease. The child must be as much as possible in the open air and should, if possible, be sent into the country. It must be put to sleep in a bed by itself to ensure fresh air during the night. If it kicks its clothes off it must be made to sleep in loose flannel drawers and a jacket, to avoid the risk of catching cold. A bath should be given, of tepid salt water in winter and cold in summer, every morning and evening, or at least once daily. The diet should be carefully regulated. Before seven months it should consist of nothing but milk; the mother's milk is the best if she be in a state of health to suckle her child; if not, the best cow's milk must be given, diluted at first with one-quarter of its bulk of warm water and sweetened with a little sugar. Lime-water may be added if the child vomits or passes undigested milk with its stools. After the child has passed the seventh month a small quantity of properly prepared starch food may be added to the diet, but the supply of milk must not be diminished; at least two pints should be given daily. Underdone meat pounded into a pulp in a mortar, or the juice of raw meat may also be given.

The remedies that are of the greatest service in rickets are iron and cod-liver oil, the former being the more important. They may be given together —one drachm of steel wine and the same quantity of the oil being taken three times a day *immediately after food.* This treatment must be continued for many months. An occasional dose of rhubarb and soda, or compound liquorice powder, may be necessary, and if the tongue be very furred a small quantity of grey powder may sometimes be added. Kassowitz recommends the administration of $\frac{1}{130}$ of a grain of phosphorus daily either in cod-liver oil or oil of almonds. He states that under its influence all the symptoms undergo rapid amelioration. It is of much importance in preventing deformity in these cases not to allow the child to walk or stand much, but to let it take exercise in donkey-panniers or hand-chairs, and to support those limbs that have a special tendency to bend, with properly constructed steel supports, which will be found of much use, provided they are not too heavy, and do not interfere with the action of the muscles. Methodical friction also should be employed to stimulate the muscles.

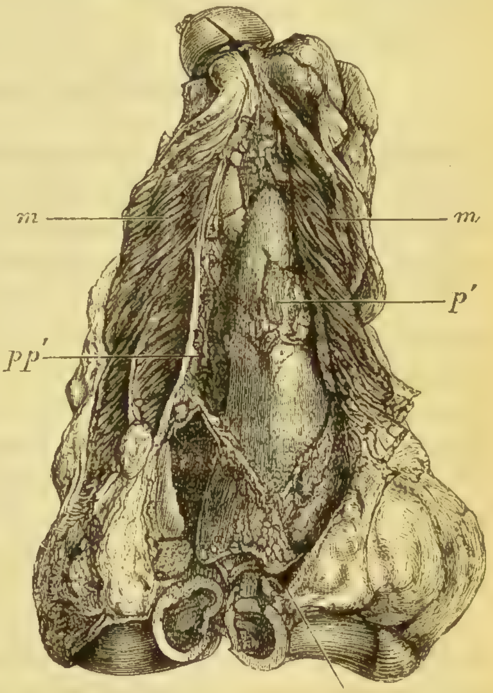


Fig. 521.—Femur from a case of scurvy-rickets. *m.* Muscle infiltrated with blood. *pp′.* Periosteum raised from the bone by clots of blood. *p′.* Clots of blood on bone. *e.* Lower epiphysis separated from shaft.

Combination of Rickets and Scurvy.—Attention has lately been drawn by T. Smith, Cheadle, and T. Barlow, in this country, and Möller and others in Germany, to a disease occurring in young children which is characterized by the following symptoms: after a few days' illness, somewhat sudden swelling takes place, evidently in connection with the bones, usually in the lower extremities, but sometimes also in the upper limbs. Of all bones the femora are most frequently affected, but most commonly the swelling is not limited to one bone. There is subcutaneous œdema, varying in amount. Acute tenderness forms a most prominent symptom, and the slightest movement evidently causes severe pain. The limbs consequently lie motionless, a condition which has been termed "pseudo-paralysis." The swelling of the bones is usually most marked near the ends of the shafts, and in extreme cases the epiphyses are found to be separated. Other bones often become affected subsequently to the first appearance of the disease. There is usually some elevation of temperature, but it seldom exceeds 101·5° F. Spongy gums are met with in about half the cases; purpura, hæmaturia, and subconjunctival hæmorrhage, have also been noted. The child soon becomes extremely anæmic, and, if not properly treated, rapidly emaciates and dies.

The fatal cases, when examined after death, have shown that the pain and swelling are due to a copious extravasation of blood beneath the periosteum stripping it widely from the bone. The disease has been described by German writers as "acute rickets," but Barlow, who has carefully analysed 22 cases, states that in three the signs of rickets were very pronounced, in seven moderately well marked, in nine slight, and in three absolutely wanting. He therefore concludes that the scurvy is the essential part of the disease, the rickets being more or less accidental, and at most favouring the occurrence of the subperiosteal hæmorrhages. In every case the disease seems to have been the effect of improper feeding, chiefly an insufficient supply of milk in infants, and want of vegetables in older children. Barlow therefore suggests the name of "infantile scurvy" for the disease. The treatment is usually successful if the disease be recognized in time. Milk, lime-juice, and fresh vegetables, with plenty of fresh air, soon relieve the symptoms.

MOLLITIES OSSIUM. OSTEOMALACIA.

Mollities Ossium is a somewhat rare disease characterized by softening of the bones. It has been studied with much attention by Curling, Solly, Stanley, MacIntyre, and Litzmann; and it is principally from their labours that we are acquainted with the chief facts relating to it.

In this disease the bones are bent, or their shafts broken in various parts of the body. Occasionally, though very rarely, only one is fractured; but in other cases, as in Tyrrell's, there may be as many as twenty-two fractures, or, as in Arnott's, thirty-one. These fractures are unattended by any attempt at the formation of callus. The body becomes singularly and distressingly distorted. On examining the bones after death the periosteum is seen to be usually redder and more vascular than natural. A section of the bone can be readily made with a knife, the osseous tissue feeling soft and gritty as it is cut. The medullary canal of a long bone is increased in diameter, the spaces of the cancellous tissue are enlarged by coalescence, after destruction of the bony trabeculæ, and the compact tissue is more spongy than natural, from widening of the Haversian canals. However advanced these changes may be, there is always a thin unaltered layer of compact bone immediately beneath the periosteum. The enlarged cancellous spaces and Haversian canals are filled with an oily, red, grumous, semi-fluid substance. Microscopic examination shows, according to Cornil and Ranvier, that the fat-cells of the medulla have disappeared to a great extent, and their place is occupied by small round cells, spindle cells, and some flattened cells. Hæmorrhages into the medullary substance are common. In the later stages the contents of the medullary spaces contain a substance resembling the splenic pulp in appearance, and the cells contain numerous pigment-granules derived from the extravasated blood. The trabeculæ of bone appear as if they had been acted on by acid. The lime-salts have disappeared from the layers of bone nearest the vessels, leaving the tissue transparent, but still showing the bone-corpuscles just as in bone artificially decalcified. This process gradually advances, and is followed by absorption of the decalcified matrix, while the corpuscles either perish or mingle with the cells of the altered medullary substance.

The term senile mollities is sometimes incorrectly applied to the atrophy of old age. In this, however, the enlarged spaces are filled with yellow fat, and not with the characteristic tissue just described.

In chemical composition, the diseased bone has been found by Leeson to be composed of 18·75 parts of animal matter, 29·17 of phosphate and carbonate of lime, and 52·08 of water in every hundred parts.

Cause.—The cause of the complaint is obscure. It has been stated that it is sometimes connected with a rheumatic tendency ; as, in every case recorded, the affection has been preceded or accompanied by severe pains, resembling rheumatism. In some instances the patients have been affected with syphilis. It most commonly, though not invariably, occurs in females, as pointed out by Kilian ; and in a majority of cases it appears to have a connection with the child-bearing state. Among 131 patients whose histories have been collected by Litzmann of Kiel, there were 85 females, in whom the disease either appeared during pregnancy or was modified in its course by this condition. Of the remaining 46 patients, 35 were females, and 11 males. It most generally attacks adults, having been observed in few cases under the age of 20 ; and it may occur even at very advanced age.

The **Seat of the Disease,** according to Litzmann, varies according as it occurs within the child-bearing period or independently of this. In 85 child-bearing women, the whole skeleton was affected in 6 cases only, and all except the bones of the head in two ; while in 46 other cases, all parts of the skeleton were diseased in 21, and all the bones except those of the head in six. The percentage of the occurrence of the disease in various parts is shown in the following table :—

	85 child-bearing women.	46 other cases.
Pelvis	96	87
Spinal Column	54	87
Chest	31	80
Lower Limb	17	78
Upper Limb	12	62
Head	8	52

In child-bearing women the disease appears to have a remarkable predilection for the pelvis ; it is probable, however, that a careful examination of all the bones has not been made in all cases.

State of the Urine.—In many cases that have been recorded, the urine has been found to contain large quantities of phosphate of lime, probably derived from the softening bones, and in one recorded by Solly, a phosphatic calculus was lodged in the pelvis of the kidney. Bence-Jones described in one case the presence in the urine of an albumenoid body, to which he gave the name of " deutoxide of albumen." It is soluble in hot water. It is dissolved by dilute nitric acid when heated, but precipitates again on cooling. Virchow has described a similar substance in the affected bones.

Symptoms.—These are, in the early stages, extremely obscure and insidious. The patient complains, in the first instance, of wandering pains about the limbs and trunk which assume usually a rheumatic character, though they have been observed to be of a much more severe, persistent, and intractable nature than those that occur in any form of rheumatism. The patient becomes debilitated, unfitted for exertion, and emaciated. Spontaneous fracture now occurs in some bones under the influence of the most trivial causes ; others become bent, and the body consequently greatly misshapen and distorted. The deformity of the pelvis is a frequent cause of difficult labour, often necessitating Cæsarean section, or Porro's operation. The acetabula are approximated by the weight of the body pressing on the heads of the femora ; thus the oblique diameters are diminished, while the pubes is carried forward, the horizontal rami often coming nearly in contact. If the patient is not pregnant, menstruation remains regular in most cases. Death usually results from general exhaustion, after a period varying from two to six years.

Diagnosis.—The diagnosis of this affection has to be made in the early stages from *rheumatism.* This is not always easy, and, indeed, is at first impossible; but after a time, when the peculiar phosphatic condition of the urine and the fragility or distortions of the osseous system manifest themselves, the true nature of the affection becomes apparent. With *rickets* it cannot possibly be confounded, as rickets is a disease of childhood, and osteomalacia is peculiar to adult or advanced life.

Treatment.—With regard to treatment, but little can be done; the administration of tonics, and a general supporting plan of treatment, may arrest for a time the progress of this terrible affection; but when once it is declared, it usually progresses from bad to worse, and at last destroys the patient. Opiates may be employed to allay the pain, and in MacIntyre's case some temporary advantage appeared to result from the administration of alum; but no remedy has appeared to be of any real advantage in this complaint. Cases have however been recorded in which, after very extensive softening of the bones, complete recovery has taken place.

OSTEITIS DEFORMANS.

In 1876 Sir James Paget read a paper before the Royal Medical and Chirurgical Society of London on five cases of a general disease of the bones to which he gave the name of **osteitis deformans**. The most marked features of the disease are the following. It begins after middle life, and runs an extremely slow course, lasting even as long as twenty years without affecting the general health to any appreciable degree. "The disease affects most frequently the long bones of the lower extremities and the skull, and is usually symmetrical. The bones enlarge and soften, and those bearing weight yield and become unnaturally curved. The spine may sink and seem to shorten with greatly increased dorsal and lumbar curves; the pelvis may become wide; the necks of the femora may become nearly horizontal, but the limbs, however misshapen, remain strong, and fit to support the trunk." The skull may become enormously thickened, yet this never gives rise to any signs of pressure on the brain. The disease is accompanied by obscure pains, not especially nocturnal. It has no connection with syphilis, gout, or rheumatism. In three out of the five cases recorded, sarcomata of bone appeared late in life. The bones examined after death show changes evidently of an inflammatory character. The skull is uniformly thickened, but in the long bones the compact tissue is chiefly affected. The thin layer of compact bone on the articular surface is thickened and encroaches on the cancellous tissue. The thickened bone is soft and spongy, its substance is very vascular, and its surface is grooved with lines for the vessels of the periosteum. Neither the periosteum nor the medulla presents any marked change.

Microscopic examination of one of Sir James Paget's cases by H. T. Butlin confirmed the opinion that the disease is inflammatory. He says: "The whole microscopic architecture of the bone had been altered; the structure appeared to have been almost entirely removed and laid down afresh on a different plan and in a larger mould." The enlarged Haversian canals contained a tissue closely resembling that found in ordinary rarefying osteitis, but more fibrillar, and containing fewer cells. In some of the canals the process of destruction was evidently progressing, Howship's lacunæ with osteoclasts (p. 265) being seen, while in other parts new bone was being formed as was shown by the presence of osteoblasts. Beyond this there is no evidence to show the exact nature or causes of this disease. No treatment seems to be of any use.

ACROMÉGALIE.

P. Marie has described under this name a peculiar disease characterized by symmetrical enlargement of certain parts of the skeleton. The parts affected are the hands and feet and some of the bones of the face and head. The enlargement of the hands takes place without appreciable alteration of form. There is no swelling or œdema, the soft parts merely being increased in proportion to the bones, so that the hands come to resemble those of a giant. The feet are similarly affected. In the face there is a spongy hypertrophy affecting chiefly the nasal bones and the jaw bones, especially the lower. Frontal bosses may develop, and the whole face thus becomes greatly increased in length and oval in form, entirely altering the features. The disease may be accompanied by severe aching pains. In all the cases recorded the thyroid body has been diminished in size or otherwise diseased. There is general weakness, but no special cachexia. No definite alteration has been noted in the urine. In women menstruation has in all cases ceased early in the disease and has not returned. The causes of the disease are very uncertain. It has been observed both in males and females, and has commenced at ages varying from 15 to 35. It is distinguished from myxœdema by the absence of any swelling of the soft parts, and from osteitis deformans by the symmetrical affection of the hands and feet, by the absence of bending of the bones, and by the early age at which it commences. No *post-mortem* examination of a case of this disease has as yet been recorded, nor has any special treatment been recommended.

TUMOURS OF BONE.

Exostosis.—By exostosis is meant the growth of a bony tumour from some of the osseous structures of the body. The causes that immediately give rise to this disease are usually extremely obscure. There can be no doubt that in some instances it is hereditary ; but, in general, it occurs without any distinct or appreciable exciting cause. It is met with chiefly in the young, developing about the age of puberty. Exostosis appears to originate in two ways : being either primarily formed as true bone developing from periosteum, or being the result of the ossification of a chondroma.

Exostoses are of two kinds—the one hard and compact, the other softer and more spongy. The hard, or **Ivory Exostosis**, is rarely multiple. It is developed from fibrous tissue, but in structure differs both in appearance and composition from normal bone. It is extremely compact and white, having a section closely resembling that of ivory, but possessing a true bony structure, Haversian canals, lacunæ, and lamellæ. In chemical composition, it is found to differ from healthy bone in containing more of the phosphate and less of the carbonate of lime, and also in the proportion of organic matter being smaller. This kind of exostosis grows principally from the flat bones and lower jaw, and, as it is generally of small size, seldom produces much inconvenience, unless it compresses important parts. Thus, Cloquet relates the case of a tumour of this kind growing from the pubic bone, and perforating the bladder; and it is occasionally found to project into the orbit, or from the inner table of the skull, upon the brain. When exostosis is left to itself, it may become stationary after a time. In some instances it has been known to necrose, and to slough away, as it were, from the parts in which it has been situated. Of this termination Hilton and Boyer relate instances.

The **Spongy or Cancellous Exostoses** grow more rapidly, often attain a considerable size, and are not uncommonly multiple. When multiple, they may be symmetrical in their arrangement, and are occasionally hereditary through several generations. Exostoses of this form are developed from cartilage. They commence almost invariably at the line of junction of an epiphysis with the shaft, and usually before puberty. When they appear at a later period it has been suggested that they arise from a portion of the cartilage of the epiphysis that has escaped ossification. When growing they are covered with a thin layer of cartilage, but should this become completely ossified, growth ceases and the tumour remains stationary. They are then composed of a thin layer of compact tissue surrounding ordinary cancellous bone; opposite the base of the tumour the normal compact tissue is wanting, so that the cancellous tissue of the tumour is continuous with that of the bone from which it is growing. The exostoses of young subjects thus frequently cease to increase when general growth comes to an end. Those commencing after that time show more continuous growth, and more urgently require surgical interference. Spongy exostoses are usually pedunculated; they are irregularly lobulated on the surface, sometimes resembling the head of a cauliflower.

Their most common seats are the lower end of the femur, the upper end of the tibia, and the upper end of the humerus. Their structure has been described and figured with Tumours (Vol. I., p. 1019).

The *Symptoms* of exostosis are simply those produced by a hard and slowly growing tumour, connected with a bone and pushing forwards the soft parts covering it. In many cases it produces serious inconvenience by its pressure, either upon neighbouring organs or mucous canals; or it may occasion ulceration of the skin lying above it. In some cases, the presence of an exostosis may be connected with an arrest of development of the bone from which it springs. Thus I have seen the lower third of the ulna completely arrested in its development by the formation of the exostosis at the lower part of the middle third, the bone being permanently shortened and dwarfed below this point.

Treatment.—If an exostosis be so situated as to occasion inconvenience or deformity, it will be necessary to remove it; and as it is a local disease, there is no fear of its return, provided this be fully done. If, however, the whole of it be not taken away, it may grow again. The removal of these tumours is best effected by a Hey's or a chain saw, or cutting pliers, or a chisel and mallet. In some situations, as when close upon joints, or springing from the cervical vertebræ, they cannot be interfered with; and in other cases, as occasionally happens in the neighbourhood of the orbit, their density and hardness may be such that the saw can scarcely work its way through them.

The **Spongy Exostosis of the Ungual Phalanx of the Great Toe** is of such frequent occurrence as to deserve special attention. It springs from the upper surface of the phalanx, near its anterior extremity, pushing the nail upwards and backwards. It may reach the size of half a cherry and project beyond the nail, giving rise to great pain and inconvenience in walking. The only treatment is complete removal of the growth with the cartilage covering it from which it grows, as if any of this be left behind, the tumour will recur. The removal is thus effected. The toe must be made bloodless by Esmarch's method. The nail is then removed in order to expose the growth thoroughly. A circular incision is then made round the tumour to the bone, and the base is cut through with a gouge or chisel. The tumour should then be carefully examined, and if it appears that any of the cartilage covering it has been left behind, this should be cut away with a gouge.

CHONDROMATA OR CARTILAGINOUS TUMOURS OF BONE are often met with. These have already been described when speaking of enchondroma and its pathology (p. 1018, Vol. I.), and need not, consequently, be more than alluded to here. They usually require resection or amputation of the affected bone, according to the attachment and size of the growth.

FIBROMA OF BONE.—Fibromata are not common in bone; when they do occur they spring from the periosteum. The situation in which they are most frequently met with is the base of the skull, from which they project downwards into the pharynx and posterior nares, forming the disease known as fibrous polypus of the nose (see Diseases of the Nose). They are also occasionally met with in connection with the jaws.

CYSTIC TUMOURS OF BONE are extremely rare, if we exclude those met with in the jaws, which arise in connection with the teeth, and those in which the cysts are merely an accidental formation in a solid tumour. The cystic tumours described by the older writers under the name of *Spina Ventosa* are always sarcomatous growths in which cysts have developed.

Nélaton describes simple cysts of bone containing a clear or reddish serous fluid, and lined with a smooth membrane having the appearance of a serous membrane, as being occasionally met with in the long bones. He states that the cysts may be unilocular or multilocular. He describes but one case as having come under his observation. The tumour occupied the femur, from the trochanter to one inch from the condyles, expanding the whole shaft to a great size. It was composed of an agglomeration of cysts, mostly about the size of a walnut, and separated from each other by bony septa. The cysts were filled with reddish serum. He states that two similar tumours have been recorded, one by Breschet and one by Travers.

The chief symptom is a slow and almost painless enlargement of the affected bone, forming a smooth, round or oval growth. The skin covering it is of normal colour. When a certain size has been attained, so that the shell of bone is expanded into a very thin lamella, and before it is perforated, pressure on the tumour occasions a peculiar crackling or rustling noise, like that produced by pressing together a broken egg-shell, or the crackling of tin-foil. Under this, the elasticity or even semi-fluctuation of the tumour may be felt. The fluctuation is particularly marked after a time, when the osseous envelope has become still more expanded, or is partially or wholly absorbed. When the shell of bone becomes very thin, spontaneous fracture may take place.

Cysts of the jaws will be more fully described with the diseases of those parts.

Treatment.—When the tumour is very large, removal of the affected bone may be necessary, but if it be of moderate size, so as not to have materially affected the integrity of the bone, it may suffice to remove one side of the wall of the cyst by the trephine or by excision, and then the cavity may be allowed to granulate, and its walls to contract. This plan has proved especially successful in some of the cystic tumours of the lower jaw; and I have practised it with success in a small cyst forming in the outer condyle of the humerus.

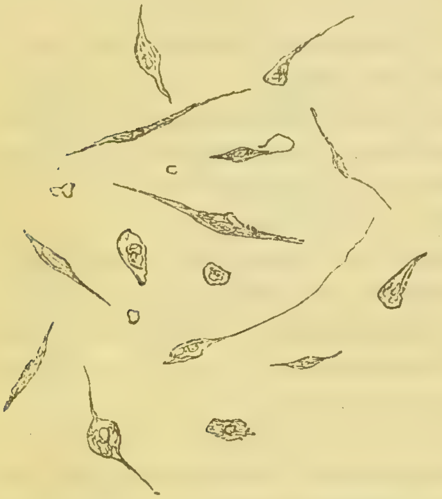


Fig. 522.—Cells from Spindle-celled Sarcoma Tumour of Scapula: First recurrence.

Hydatids.—Cavities are occasionally, but very rarely, found in bones, in which large numbers of hydatids are lodged; according to Stanley, both the echinococcus and the cysticercus cellulosæ have been found in this tissue, but most frequently the former. In these cases a cyst forms in the bone, which becomes thin and expanded, resembling the ordinary fluid cystic tumour, but which, on examination, is found to contain the parasite. The *Treatment* must depend on the situation and extent of the disease; if it be a long bone that is affected, and it be much expanded, recourse must be had to amputation; if it be a flat bone, the cyst-wall must be scooped out, and the cavity dressed from the bottom with stimulating applications.

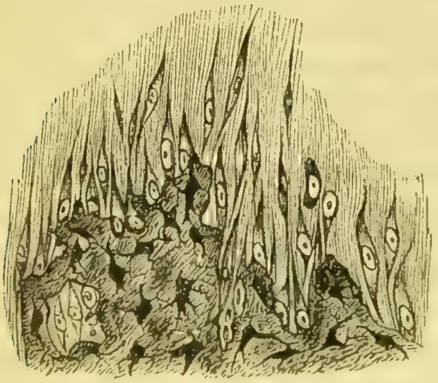


Fig. 523.—Ossifying Spindle-celled Sarcoma Tumour springing from the Scapula.

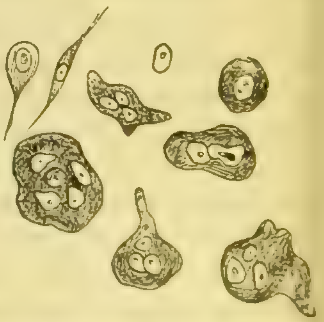


Fig. 524.—Microscopic Characters of the Tumour in its second Recurrence. Multinucleated Myeloid Cells.

Sarcomata of Bone—Primary Malignant Tumours of Bone.—It is now generally recognized that true cancer never originates in bone, and that the tumours formerly classed as primary encephaloid or scirrhous cancer of bone, osteo-cancer, osteo-cephaloma, &c., all belong to the class of sarcomata. The fact that there has not been a single well-authenticated case of primary cancer of bone recorded since the distinction between carcinoma and sarcoma was clearly established, is strong evidence in favour of the view that all true cancer commences in connection with pre-existing epithelium. It is only in such bones as the superior maxilla, and those in connection with the mucous membrane lining the cavities of the face, that true cancer is commonly met with ; and here the osseous tissue is involved only by extension of the growth, the primary seat of the disease being the mucous membrane.

The subject of sarcoma of bone has been very thoroughly investigated by S. Gross of Philadelphia and by H. T. Butlin of London, and much light has been thrown by them upon the clinical and pathological features of this disease. For the purpose of classification, sarcomata of bone are divided, first into *central,* springing from the cancellous tissue or the medullary canal, and *periosteal, subperiosteal* or *peripheral,* arising on the surface of the compact bone ; secondly, they are subdivided according to the structure of the growth, into *spindle-celled, round-celled, mixed spindle- and round-celled and myeloid.* Gross makes a separate division for osteoid or ossifying sarcoma, and separates cartilaginous tumours entirely, placing them in another group. Butlin classes ossifying sarcomata and chondro-sarcoma, according to the form of the cells (spindle, round, or mixed,) met with in the growing margin of the tumour. The microscopic structure of these various forms of sarcoma has been already described in the Chapter on Tumours (Vol. I., p. 1036). Gross gives the following as the relative frequency of the different forms of sarcoma among the 165 cases affecting the long bones which formed the basis of his paper. Central myeloid sarcoma, 70 ; periosteal ossifying sarcoma, 45 : central spindle-celled sarcoma, 16 ; periosteal round-celled sarcoma, 13 ; central round-celled sarcoma, 12 ; periosteal spindle-celled sarcoma, 9. Of all forms of sarcoma, out of 149 cases, 87 occurred in males and 62 in females ; and of 147 in which the age was ascertained, 110 occurred before 30. The central spindle-celled sarcoma was the only form that Gross found to occur more frequently after 30 than before. In almost half the cases the disease was attributed to injury. The various long bones were affected in the following order : femur, 67 ; tibia, 46 ; humerus, 25 ; fibula, 13 ; ulna, 7 ; radius, 6 ; ulna and radius, 1. The following table, showing the malignancy of the various forms of sarcoma affecting the long bones, is so important that I reproduce it entire.

FORM OF SARCOMA.	INFECTED NEIGHBOURING SOFT PARTS.	INFECTED LYMPHATIC GLANDS.	RECURRED LOCALLY AFTER REMOVAL.	INFECTED THE SYSTEM GENERALLY.
	Per cent.	Per cent.	Per cent.	Per cent.
PERIOSTEAL :—				
Spindle-celled	44	0	60	100·
Round-celled	54	7·69	50	66·66
Ossifying	40	6·25	41	65·62
CENTRAL :—				
Round-celled	66	8·33	25	33·33
Spindle-celled	18	0	20	23·07
Myeloid	12	0	8	22·72

When internal organs become affected, the secondary growths will generally be found in the lung, and sometimes also in the liver and other viscera. The secondary tumours, as a rule, reproduce the special features of the primary, such as ossification, calcification, development of cartilage, &c. (Fig. 524).

In **Central Sarcoma of Bone** the tumour springs from the cancellous tissue or medullary canal. It is usually situated at or about the articular ends, expanding the bone, until in many cases a thin shell only is left surrounding the mass. The symptoms may at first closely resemble those of chronic periostitis and osteitis, or abscess of bone, the only means of diagnosis sometimes being the application of a trephine. In most cases, however, the pain is not so severe as in chronic inflammatory affections. It has been pointed out by Richet, and I have often had occasion to verify the fact, that, though the articular end of the bone may have been completely destroyed by the tumour, the cartilage of the neighbouring joint never becomes implicated. In these cases the close proximity of the tumour to the joint may lead to the disease being mistaken for white swelling of the articulation, as I have more than once seen happen in myeloid sarcoma of the lower end of the femur. The cartilage, however, being undestroyed, there is in these cases usually a considerably greater degree of movement than is possible in white swelling. Central sarcoma, so long as the disease is confined within the walls of bone, develops but slowly and shows but little tendency to infect the system, but when once it extends beyond and implicates the soft parts, the danger becomes greatly increased. Spontaneous fracture is not uncommon. Central sarcomata are of four kinds, myeloid or giant-celled, spindle-celled, round-celled, and mixed spindle- and round-celled. These are further modified by the formation of cysts, calcification, ossification, and the development of cartilage. Eighty-one cases collected by Butlin showed the following structure : round-celled 22, of which 17 were simple, 1 calcified, 3 ossifying, and 1 fibroid ; spindle-celled 19, of which 15 were simple, 2 developing cartilage, and 2 calcified ; mixed-celled 22, of which 18 were simple, 3 ossifying, and 1 calcified ; and myeloid 17, of which 14 were simple and 3 contained bony spicula. According to Gross, if the long bones only be considered, myeloid tumours form a much larger proportion than in Butlin's table.

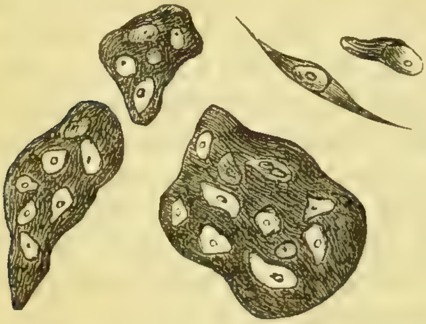


Fig. 525.—Myeloid Plates or Giant-cells from a Tumour of the Lower End of the Femur.

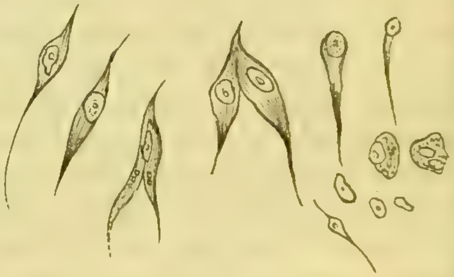


Fig. 526.—Fusiform and oat-shaped Cells from Myeloid Tumour.

All the central sarcomata, except the myeloid, tend to diffuse themselves widely through the medullary canal ; the myeloid tumour often remains tolerably sharply limited to the articular end of the bone in which it commenced. As a central sarcoma grows, the bone becomes "expanded" by it till a mere shell, often deficient in parts, is left. If the tumour be very soft or contain cysts, this may in parts give the sensation of "egg-shell crackling."

In **Peripheral**, or **Periosteal Sarcoma**, there is no expansion of bone. The tumour is from the first elastic and fixed, commencing usually at one side, but often at a later period embracing the whole bone. The forms of sarcoma met with in 80 examples collected by Butlin were the following: round-celled 30, of which 22 were simple, 6 ossifying, and 2 chondrifying; spindle-celled 22, of which 13 were simple, 3 ossifying and 6 chondrifying, and in some cases subsequently becoming ossified or calcified; mixed round- and spindle-celled 28, of which 11 were simple, 6 ossifying, 5 calcifying, and 6 developing cartilage. When the tumour ossifies or calcifies it does not penetrate deeply into the compact tissue; when these changes do not take place the bone becomes eroded and spontaneous fracture is very likely to occur. The pain accompanying a subperiosteal tumour is usually less severe than that of a central sarcoma. The tumour varies in consistence according to its nature from firm and elastic to semi-fluctuating. In some cases pulsation of a thrilling kind, with or without a bruit, is distinctly perceptible, especially in an advanced stage of the disease, when the vascularity of the

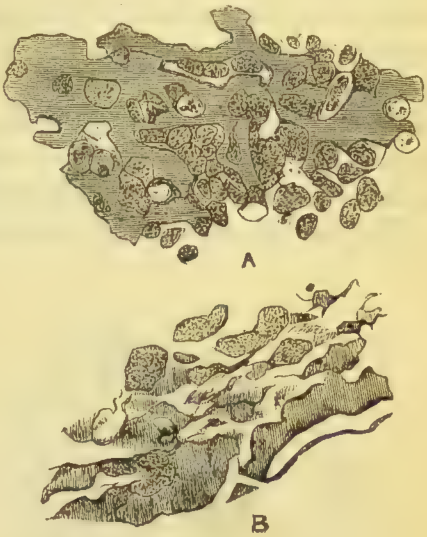


Fig. 527.—Calcified Nodule of Sarcoma of the Lung, secondary to a similar growth in a long Bone (188 diam.) A. Decalcified. The flat grey Surface represents the Calcified Stroma. B. Not decalcified. Shows the glistening bars of Calcified Stroma passing between the granular cells, which in some parts also are calcified.

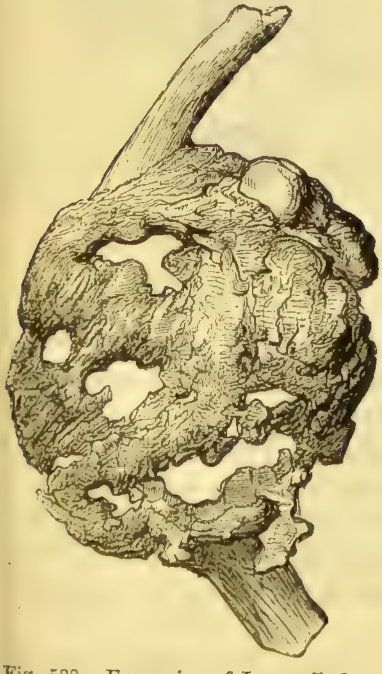


Fig. 528.—Expansion of Lower End of Femur by a Myeloid Sarcoma.

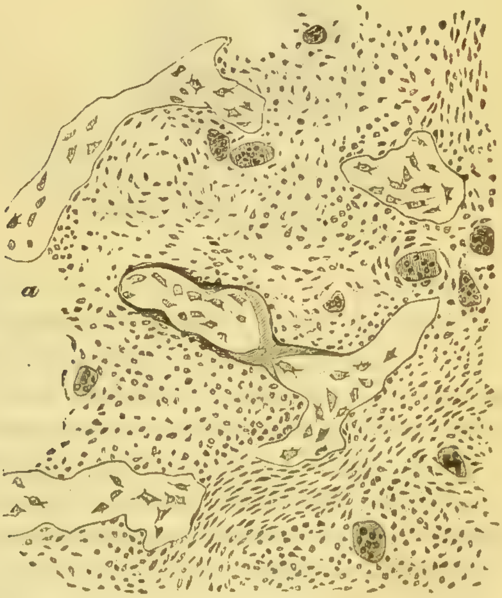


Fig. 529.—Myeloid Tumour of Lower Jaw (70 diam.), showing the manner in which the bone is invaded. *a*. The deep surface of the section.

tumour is greatly increased. Cysts are not uncommon in the softer forms of sarcoma.

Diagnosis.—Central sarcoma of bone in its early stages so closely resembles *chronic osteitis and periostitis* that it is frequently impossible to come to a correct conclusion as to the nature of the case without cutting down on the bone and applying the trephine. In the later stages the diagnosis becomes more easy ; the great enlargement of the bone, the occurrence of "egg-shell crackling" on pressure, and more especially pulsation when it is present, making the nature of the case clear.

From *cystic tumours* of bone the diagnosis is often impossible, as the great majority of "cysts of bone" (except in the jaws) are really soft sarcomata with cysts developed in the tumour. It is only by cutting into the affected part that the nature of the disease can be ascertained. From *disease of the neighbouring joint*, the diagnosis is made by observing that the joint does not form the centre of the swelling, and that movement, although limited is not painful, and is unaccompanied by grating or crackling in the articulation. Should the tumour have penetrated the joint, which is very rare, the difficulty of diagnosis becomes greatly increased.

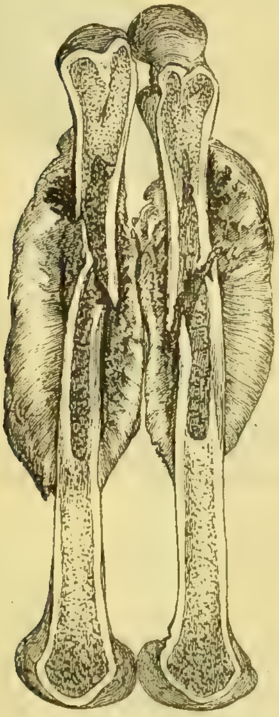


Fig. 530.—Peripheral Spindle-celled Sarcoma of Shaft of Femur sawn open. Spontaneous Fracture.

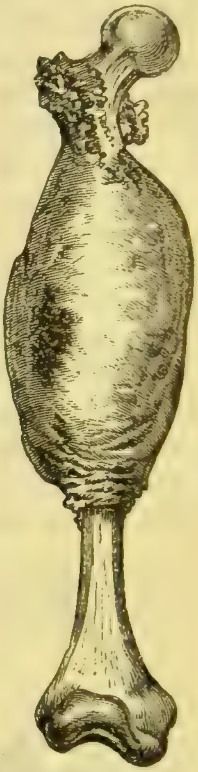


Fig. 531. — Peripheral Spindle-celled Sarcoma of Shaft of Femur, successfully Amputated at Hip-Joint.

Peripheral Sarcoma is most frequently mistaken for a deep-seated *chronic abscess*, but the absence of true fluctuation, the presence of a rounded edge to the tumour, and its fixed attachment to the bone will usually enable the Surgeon to recognise the nature of the disease. In all doubtful cases the swelling must be punctured with an aspirator. Even when the presence of a tumour is evident, it is not always easy to make sure that it is attached to the bone. Examination under chloroform, with complete relaxation of the muscles, will usually, however, overcome this difficulty.

The diagnosis from *aneurism* is necessarily unattended by any difficulty so long as its sac is pervious to fluid blood, and presents the characters that are met with in this condition. But if the sac have become consolidated by the deposit of stratified fibrin, and thus have assumed the characters of a solid tumour, it may readily enough be mistaken for a growth springing from the osseous structure, and amputation has occasionally been performed on this supposition (as in Fig. 451). Pulsating sarcoma may be mistaken for *aneurism by anastomosis.* In such cases, however, the history of the progress of the disease will do more to elucidate its true nature than anything else.

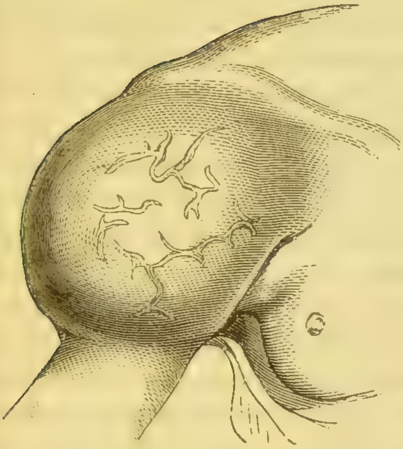


Fig. 532.—Rapidly growing malignant Tumour of the Head of the Humerus, with Spontaneous Fracture of the Shaft.

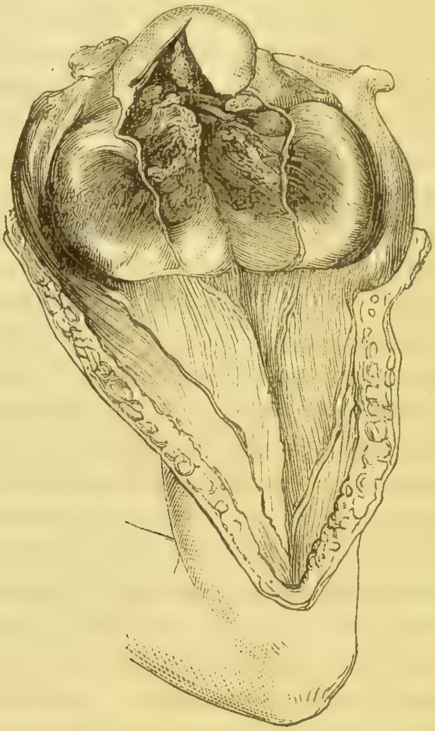


Fig. 533.—Section of rapidly growing malignant Tumour of Head of Humerus: upper end and Head of Humerus destroyed, but Cartilage of Incrustation unaffected. Tumour divided by white vertical lines—the Periosteum: inside which only were the Osseous Spicula found.

Having ascertained the presence of a tumour, it remains *to determine the nature of the growth.* In many cases this cannot be done. If the tumour is of slow growth, very firm, of considerable size, lobulated on the surface, very clearly defined, and immovably fixed to the bone, it may be a simple chondroma. If, with the same symptoms, however, it is of more rapid growth, it may be a sarcoma developing into cartilage. The distinction is very important if it can be made, for a simple chondroma is an innocent tumour, and the Surgeon in removing it may carry his knife close to the growth, but a chondrifying sarcoma is usually very malignant, and amputation must be done high above it. Unfortunately the distinction is often impossible. When the tumour is central and situated at an articular end of a long bone, especially the upper end of the tibia, the lower end of the femur, the upper end of the humerus or the lower end of the ulna, or on the lower jaw, the chances are greatly in favour of its being a myeloid sarcoma. According to Gross, nearly 70 per cent. of the central tumours of the long bones are of this nature. Myeloid tumours are often somewhat globular in form, and cysts are very common in them. They usually occur between 25 and 35, and grow slowly without affecting the constitution. When the central tumour affects the shaft of a bone it is probably one of the more malignant sarcomata, either round-celled, spindle-celled or mixed, myeloid being very rare in this situation.

The peripheral sarcomata cannot be clearly distinguished from each other. Myeloid never commences superficially, and may therefore be excluded. If the lymphatic glands are affected, it is most probably a round-celled sarcoma, the spindle-celled form very rarely spreading in this way. All forms of peripheral sarcoma may equally implicate the surrounding soft parts.

In distinguishing between the benign and malignant tumours, Paget directs attention to the following points: 1. The age of the patient. If below puberty or past middle life the tumour is probably malignant, unless it be a common exostosis. 2. The age of the tumour. If of more than two years duration, it is probably not malignant. 3. If a tumour of bone have doubled its size in six months, not being inflamed, it is probably malignant.

Treatment.—Tumours of bone are necessarily beyond the reach of constitutional or local resolvents. Surgeons are consequently obliged to resort to operative interference. If the tumour be simple, it may be possible to remove it in some cases by gouging or cutting it out, but if it be one of the malignant sarcomata, the only safe course consists in removing the whole bone from which it springs. If from the localized nature of the growth, its origin at an articular end of a bone, and its central position, there is reason to believe that it is a myeloid or giant-celled sarcoma, it may be sufficient to remove only the part of the bone from which it grows. In the leg this necessitates amputation, but in the lower end of the radius, or the upper end of the humerus, it is sometimes possible to excise the affected part of the bone without removing the limb. In tumours of the lower jaw it is seldom necessary to remove more than half the bone at most. If part of the bone only be removed, the sawn surface and medullary canal must be carefully examined, and if they do not appear healthy more must be cut away.

If the tumour be peripheral, or if it be a central sarcoma of any kind other than myeloid, no means avail except the complete removal of the diseased bone. These operations are, however, not very promising, as there are few forms of malignant tumour in which the disease returns more rapidly in a secondary manner than in that of the bones. The rapidity of recurrence will, however, greatly depend upon the form of the disease, on the time when *amputation* is performed, and on the part where it is practised. Amputation should always, if possible, be performed in the earliest stage of the disease, before general infection has taken place. If the glands be enlarged, and cachexy be already present, little can be expected in the way of ultimate cure: yet I have known cases in which, even in these unfavourable circumstances, the patients have made a good recovery, life having been prolonged for months.

The selection of the line at which amputation should be performed is of great importance, and the result will materially depend upon the judgment displayed in this. If the limb be removed in the continuity of the diseased bone, there must necessarily be a great probability of a very rapid return of the growth in the stump; and this probability amounts to a certainty in those cases in which, the disease being central, the whole of the medullary canal and cancellous structure are infiltrated by the tumour. In cases of peripheral disease, this return may not take place in the same bone; indeed, I have seen one case of the kind in which the disease affected the lower end of the tibia, and that bone was amputated in its upper third; in this case, after a lapse of some months, fatal recurrence of the disease took place in the pelvic bones, but not in the stump. As, however, the peripheral is more rare than the central form of the disease, and as there are no means of ascertaining the precise kind before removal, the rule, I think, should be absolute to amputate at or above the next joint—at the hip-joint, in malignant disease of the femur; in the thigh, for that of the bones of the leg; and at the shoulder, when the upper arm is affected. When the lower part of the femur, however, is involved, amputation through the trochanters may sometimes be substituted for disarticulation at the hip-joint, the latter operation being so formidable and so fatal that the Surgeon may think it advisable not to subject the patient to so serious a risk; or amputation might be performed through the trochanters, and the head of the bone then resected. In this way the severity of the operation and the extent of wound would be lessened, whilst the whole of the diseased bone would be removed. In cases of myeloid sarcoma it is not usually necessary to remove the whole bone, as the disease almost invariably begins in the articular ends, and rarely extends far into the medullary canal.

In some forms of malignant bone-disease, however, the muscles inserted into the affected bone become speedily contaminated, and this contamination may spread widely through the substance or along the sheath of any particular muscle. Hence I think the rule in these cases should be to amputate not only above the diseased bone, but, if practicable, above the origins of the muscles in the neighbourhood of the disease: thus, if there be a malignant tumour of the bones of the forearm, amputation should be done not only above the elbow-joint but above the humeral attachments of the muscles of the forearm.

The propriety of *excision* of some bones, as of those of the face, in this disease, must depend on whether the morbid growth is limited to the structures that can be excised. This operation can rarely be advantageously practised in malignant tumours, there being in general too great an implication of the soft structures in the neighbourhood to justify it.

SECONDARY SARCOMATA OF BONE.—All malignant sarcomata, wherever arising, when they become generalized, may form secondary growths in the bones. Thus in a case of sarcoma of the breast under my care some years ago, the fatal result was due to a secondary tumour forming in the sternum. Melanotic sarcoma not unfrequently gives rise to secondary tumours in the medulla or cancellous tissue of bones.

TRUE CANCER OR CARCINOMA OF BONE is always secondary. **Scirrhus**, when it becomes generalized, not unfrequently gives rise to secondary tumours of bone. Five cases of this kind have occurred lately in University College Hospital, which are good examples of this. Four occurred after excision of the breast. In two, the secondary tumour formed in the vertebræ, in one, in the ribs, and in one, in the femur. In the fifth case, in an apparently healthy man, the upper jaw was excised for what was supposed to be a primary tumour of the outer part of the upper maxilla and the malar bone. After death a primary scirrhus cancer of the pancreas was found, and the tumour of the jaw presented the same structure.

Squamous Epithelioma of bone very rarely occurs as a secondary growth, although one such case has occurred in University College Hospital. It is usually the result of direct extension from the primary tumour.

A very rare form of malignant growth is occasionally met with in the thyroid body, which almost exactly resembles the normal gland in structure. It has a peculiar tendency to give rise to secondary tumours of the same structure in the bones. Cases of this kind have been recorded by Cohnheim, Morris, and others. In some cases they have pulsated strongly.

All secondary cancerous tumours of bone are central, commencing either in the medulla or cancellous tissue.

PULSATING TUMOURS OF BONE—OSTEO-ANEURISM.—Pulsating tumours of bone, or osteo-aneurisms, are a mixed group of growths possessing in common only one feature, that they pulsate strongly, so as in some cases almost to resemble a true aneurism. The great majority of these are soft vascular sarcomata, in which, as Billroth has pointed out, small aneurismal dilatations may exist on the vessels, which form a close network throughout the mass. Gross states that pulsation was present in 20 per cent. of the myeloid tumours, in 12 per cent. of the central spindle-celled growths, and in 33 per cent. of the central round-celled sarcomata, of which he had collected the records. In peripheral sarcomata pulsation was very rare. It is evident that pulsation cannot be recognized in central tumours until the bony wall has been completely destroyed at one side, and it is possible that the frequency with which central tumours pulsate distinctly after this has taken place may be due to the fact that the vascular mass of the tumour is surrounded on all sides but one by unyielding bone.

Excluding all these cases, two other kinds of pulsating tumours have been described as occurring in bone. In one of these, which is very rare, there is developed in the bone a structure, which is composed of a **vascular erectile growth,** closely resembling a capillary nævus in structure, composed of an infinity of vessels, interlacing in every way, so as to form a soft reddish tumour (Fig. 534). In the second form a hollow cavity is formed in a bone, scooped out of the cancellous structure and filled with blood, partly liquid and partly coagulated, and having arterial branches opening into it. The shell of bone surrounding this cavity is very thin and expanded, and after a time is usually completely absorbed on one side. This constitutes the "**true aneurism of bone.**" Its mode of origin is uncertain. Volkmann suggests that in some cases it may be a soft sarcoma, the original tissue of which has been entirely softened and broken down by hæmorrhage into its substance. Such cases are extremely rare, and until some have been recorded with accurate microscopic examination of the contained clot and the surrounding bone we must hesitate to form any opinion as to their true nature.

Situation.—Pulsating sarcomata may be found anywhere, but are most common in the bones of the skull, the lower end of the tibia and upper end of the femur. Nævoid growths are most common on the skull. The "true aneurism of bone" has been said to occur most frequently in the head of the tibia.

Symptoms.—When the tumour is merely a highly vascular sarcoma, the symptoms that it gives rise to are the same as those already described as indicating a central sarcoma of bone, with the addition of pulsation and bruit. In these the pulsation is very marked and superficial, and commonly of a thrilling character ; it may be distinctly expansile ; the bruit is usually soft and blowing, but not unfrequently harsh, loud, and whizzing. In true osteo-aneurism, according to Nélaton, the bruit is often absent. In pulsating sarcomata I have heard the bruit peculiarly loud, rough, and superficial. On compressing the main artery leading to the part of the limb in which the tumour is situated, all movement and bruit commonly cease in it, and the tumour lessens in size. By pressing upon the growth when it is thus diminished, if it be a "true aneurism of bone," it will commonly be found to have a bony margin, with a central depression. In some cases the tumour is fed by several arterial branches, which may be felt distinctly pulsating under the skin. This is more particularly the case in soft sarcomata occurring upon the bones of the pelvis and the scapula, and then the bruit and pulsation cannot be made to cease in it. All these signs are commonly somewhat intermittent, the pulsation appearing perhaps in the earlier stages of the disease, and disappearing as it advances ; or the reverse may occur, the pulsation and bruit becoming distinct as the disease increases in size and meets with more resistance in its outward growth.

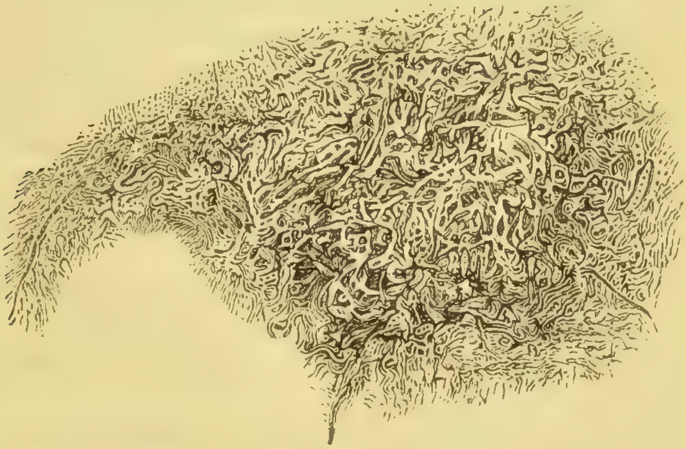


Fig. 534.—Aneurism by Anastomosis of one of the Parietal Bones.

Diagnosis.—It is of considerable importance to diagnose the different forms of pulsating tumour of bone from one another, as both the treatment and prognosis differ according as the disease is a "true aneurism of bone," or a pulsating sarcoma. The true osteo-aneurism is so rare that its existence is often denied, and should it be met with it will have so many signs in common with the *pulsating* sarcoma, that it will be almost impossible to make the diagnosis. It is well to bear in mind that the malignant sarcomata are sometimes multiple, occurring, with pulsation and bruit, in more situations than one ; thus I have seen growths of this kind springing both from the pelvis and from the ribs. The true osteo-aneurism has been described as occurring only in the articular ends of long bones; whereas the malignant disease, though commonly occurring in these situations, is also frequently found in other parts of the body. Besides these, there are two conditions which, in many cases, will enable the Surgeon to determine that the pulsating tumour is an osseous aneurism : viz., the absence of all bruit, though the pulsation be distinct, and the detection by firm pressure, after the tumour has been diminished by compressing the artery leading to it, of an osseous margin around its depressed centre.

From *ordinary aneurism* the diagnosis of pulsating tumours of bone may be attended by almost insuperable difficulties. So great are these, that there are many cases on record in which the most experienced Surgeons have ligatured arteries for tumours that were supposed to be aneurismal, but which have turned out to be pulsating sarcomata. A principal point to be attended to in making the diagnosis is the situation of the tumour, which may occur in a part of the body where there is no vessel large enough to give rise to such a disease—as, for instance, about the head of the fibula or the outer side of the pelvis. Then, again, its incorporation with the subjacent bone, the want of a distinctly limited and circumscribed outline, and the existence in many cases of plates of bone in the wall of the tumour—giving rise, perhaps, on pressure, to the peculiar rustling or crackling sound characteristic of central bony growths—will enable the Surgeon to come to a correct conclusion. In this he will be further assisted by its having on compression a soft, doughy, or spongy feel, or appearing as a depression surrounded by an osseous margin. In many cases also, the less impulsive character of the beat of the tumour, the peculiar shrill and tremulous whiz in the pulsation and bruit, will throw much light on the nature of the disease. But it cannot be doubted that, when tumours of this kind occur in some of the ordinary situations of aneurism, as about the brim of the pelvis, and in the popliteal space, the diagnosis is surrounded with difficulties which no amount of surgical skill may be able to overcome.

From *ordinary tumours of bone*, the existence of pulsation and bruit will always suffice to distinguish the growths under consideration.

Treatment.—Pulsating sarcomata of bone must be treated exactly in the same way as those that do not pulsate.

Ligature of the main artery has been practised in several supposed cases of "true aneurism of bone," but in the majority of these the disease turned out to be a soft sarcoma, and consequently no benefit resulted. The growth of the tumour was not even retarded. Roux, however, has recorded a case in which he cured a pulsating swelling in the lower end of the radius by ligature of the brachial artery. Lallemand cured a so-called aneurism of bone by the same treatment. In a patient of Dupuytren's no return of the disease took place for six years, when it recurred, and amputation became necessary.

CHAPTER XLVIII.

DISEASES OF JOINTS.

The various joints of the body may become the seat of Inflammatory Affections of an acute or chronic character ; of Strumous or Tubercular Disease ; or of various other morbid conditions, such as more or less permanent rigidity, or Ankylosis, the formation of Foreign Bodies within their cavities, and Neuralgia. In studying these various articular affections, it must be borne in mind that a joint is composed of a number of different tissues ; of synovial membrane, cartilage, bone, ligament, and capsule, or investing fibrous expansion. In any one of these structures the disease may primarily begin, though eventually the morbid process often spreads to other tissues besides that which was originally involved. The merit of having been the first to point out the true mode of studying these affections in reference to the different structures in which they have originated, and to have set aside that coarse pathology which, under the general terms of "arthritis" and of "white swelling," confounded together these various diseases, is certainly due to Sir Benjamin Brodie.

Inflammation of the Synovial Membrane may occur under two forms, simple or serous, and purulent or suppurative. In the former the disease affects the synovial membrane only, and has little tendency to extend to the other structures of the joint ; in the latter the capsule, and ligaments, the cartilages and even the bones ultimately become implicated unless the inflammation is arrested by treatment, and consequently this form soon merges into the affection known as acute arthritis, with which it will be described.

Clinically the term Synovitis used by itself is commonly applied only to the serous form.

Serous or Simple Synovitis is, perhaps, the most common of all articular affections. It may be acute, subacute or chronic.

Acute Synovitis—Causes.—Simple acute synovitis is most commonly of traumatic origin, arising from blows on the joint, bruises or sprains. In other cases it occurs without apparent external cause, and is then usually due to exposure to cold, especially in rheumatic or gouty constitutions. In these cases it commonly happens that more joints than one are implicated at the same time ; the affected articulations are more frequently those that are most exposed by having the thinnest covering of soft parts and by being especially subjected to variations of temperature, such as the knees and ankles. Gonorrhœa is an occasional cause of inflammation of the synovial membrane (see Gonorrhœa, Chap. LXXII.). In very rare cases a subacute form of synovitis with moderate effusion is met with in the secondary stage of syphilis at the same time as the cutaneous eruptions. Still more rarely acute inflammation with exudation into the joint is met with in acute tuberculosis as a consequence of miliary tubercle of the synovial membrane. Somewhat sudden distension of the synovial membrane, often with swelling of the whole affected limb, is one of the phenomena not uncommonly observed in Charcot's disease of joints (see Charcot's Disease).

Pathology.—As uncomplicated acute synovitis is never fatal, we seldom have an opportunity of studying its pathology. It would, however, appear from the examination of joints in cases of synovitis from injury, as well as from the experiments of Richet, Bonnet, and others, who have induced traumatic synovitis in animals, that there is in the first instance an inflammatory congestion of the synovial membrane, with loss of its peculiar satiny polish. The synovia is then increased in quantity, and becomes thin and serous, and after a time intermixed with inflammatory exudation which is poured out with it. If the disease progress favourably, these products are completely absorbed. In more rare cases, the congestion and swelling of the synovial membrane increase, until at last it becomes so turgid and distended with blood and effused fluids, that a kind of chemosis results; a thin purulent-looking fluid is poured out, composed of granular corpuscles—partly migrated leucocytes, and partly desquamated and degenerated endothelial cells—floating in a serous liquid.

In all cases of acute synovitis the fringes of the membrane become swollen, and their vessels injected with blood, so that they form prominent red elevations, especially at the margins of the cartilages. The inflammation in such cases frequently extends to the other structures forming the joint, and the disease then forms one variety of acute arthritis. In other cases, granulations are thrown out on the looser portions of the membrane, and becoming injected with blood-vessels, constitute fringed and villous membranous expansions, lying upon the subjacent cartilage.

Symptoms of Acute Synovitis.—The symptoms of synovitis consist of pain and heat and distension of the joint, with fluctuation. If it be large and exposed, the *pain* is sometimes severe, especially at night, being greatly increased by moving or pressing upon the articulation; it is usually sharp, but when the disease occurs in rheumatic or gouty constitutions, it is of a gnawing character. On laying the hand on the joint, it will be felt to be *hot.* The *swelling* of the affected joint is considerable, and evidently depends on accumulation of fluid within the synovial sac, the extreme outline of which is rendered apparent by the tension to which it is subjected. Thus in the knee it rises up high in the thigh under the vasti, to the extent of three or four inches above the upper border of the patella, the swelling being higher on the inner than the outer side of the limb, whilst in the elbow it rises in the same manner under the tendon of the triceps. There is no effusion into the surrounding tissues; and hence the outline of the joint can be distinctly felt, and *fluctuation* perceived in it. The limb is usually semiflexed, for in this position there is the greatest general relaxation of the ligaments, and it consequently gives the patient most ease. The joint cannot be moved without pain. The constitutional febrile disturbance is tolerably severe, especially if the affection occur in a rheumatic constitution.

Chronic Serous Synovitis is characterised by effusion of serous fluid into the cavity of the joint without any tendency to the formation of pus, and in fact without any of the ordinary signs of inflammation. The pressure of the fluid distending the capsule and causing swelling and weakness of the joint is the prominent symptom. There is little or no pain, tenderness or heat in the affected joint.

The presence of an abnormal quantity of fluid in the joint is always indicated by *fluctuation* and *undulation* and by the *peculiar shape* acquired by the part. Thus in the knee, which is the most common seat of the affection, the patella will float, as it were, on the fluid. If the distension be not too great, by placing the finger on the knee-cap and pushing it sharply towards the femur it can be felt to sink through the fluid and strike on the bone beneath. This sign is of great importance, as it enables us to distinguish between simple synovitis with effusion, and distension of the joint by soft granulation-tissue in the early stages of white swelling. In order to elicit it the patient must be lying down with the muscles of the thigh perfectly relaxed. All the natural hollows about the knee are obliterated ; the distended pouches of the synovial membrane project distinctly on each side above the patella, and the hollow on each side of the ligamentum patellæ is obliterated by the infra-patellar fat which is pushed downwards by the pressure of the fluid in the joint. In the elbow there is a soft and fluctuating swelling extending above the olecranon on each side of the tendon of the triceps which forms a depression in the middle line ; and in the shoulder there is a general roundness and distension of the articulation.

The term **Hydrarthrosis** or **Dropsy of the Joint** has been applied to cases in which the amount of fluid distending the joint is considerable, and the course of the disease extremely chronic. The fluid in these cases partakes in various degrees of the characters of serum and synovia. Hydrarthrosis may arise from at least three distinct pathological causes. First, the effusion may be preceded or accompanied by the ordinary evidence of synovial inflammation, the case apparently being merely one of simple synovitis with very excessive effusion. Secondly, great effusion into the joint is not an uncommon occurrence in Charcot's disease. In this form the effusion is painless or nearly so, and is soon followed by destructive changes in the cartilages and bones with looseness of the ligaments and unnatural mobility of the articulation. (See Charcot's Disease of Joints.) A third form has been described by König under the name of *hydrops tuberculosus* or *tubercular dropsy* of the joints. It is characterised by very chronic effusion usually moderate in amount and refusing to yield to treatment, or if any improvement takes place, speedily relapsing. The movements of the joint are limited but not painful. There is usually thickening of the synovial membrane, which may be readily felt if the distension is not great. In some cases, in the knees, König has felt a distinct fibroid mass resembling a tumour at the lateral reflexion of the synovial membrane. He states that tubercular dropsy may be caused by diffuse tuberculosis of the synovial membrane with or without marked thickening. When the membrane is thickened it is due, in some cases, to the deposit of fibrinous layers upon it, especially on the fringes which may become villous or even polypoid in appearance, sometimes forming the tumour-like masses above mentioned. In these cases melon-seed bodies may be present in the joint. In other cases obstinate dropsy of the joint has preceded ordinary white swelling. The evidence that the conditions above described are tubercular is derived from the presence of typical tubercle nodules, with giant cells in portions of the membrane removed by incision into the joint. Tubercular hydrarthosis occurs most commonly in young adults, very rarely in children.

In all forms of hydrarthrosis, if the distension is considerable, pouch-like projections of the synovial membrane may push their way through the least supported parts of the capsule, and form tumours resembling cysts in the neighbourhood of the joint. When a bursa communicates with the synovial membrane it becomes distended with the joint in hydrarthrosis, as for example the bursa under the inner head of the gastrocnemius and that beneath the deltoid. It is said that, in some cases, the distension of the joint has been so great that the synovial membrane has been ruptured, and the fluid poured forth into the surrounding areolar tissue. In these cases, however, it is probable that some destructive change in the synovial membrane preceded its rupture. In more chronic cases the ligaments may become relaxed, and spontaneous dislocation may take place. (Vol. I. p. 660.)

In some cases of chronic synovitis distinct *crackling* will be felt in the interior of the joint, on laying the hand over the articulation, whilst it is freely moved. This appears to me to be due to the existence of bands of fibrinous exudation in the interior of the joint, through which the fluid is pressed by the articular movements, and thus occasions the sensation which is met with under similar circumstances in enlargements of the bursæ, and in fluid effusions in the sheaths of tendons.

Terminations.—The termination of serous synovitis will depend mainly on its cause. When simple and uncomplicated, arising as the result, perhaps, of rheumatic influences, it will in most cases end in complete resolution. In other instances, however, as a consequence of inflammatory exudation, warty vegetations or concretions may form within the joint, or bands stretching across its interior or incorporated with its capsule may occasion more or less permanent stiffness. Chronic or subacute synovitis, when simple, usually terminates favourably, although the joint is often left in a weak state from which it may not recover for many months.

The termination of chronic hydrarthrosis will depend to a great extent on its cause. If due to Charcot's disease the fluid is usually absorbed more or less completely after some time, but the deformity of the joint of course remains. (See Charcot's Disease.) In tubercular dropsy recovery may take place under proper constitutional and local treatment with perfect rest, but not uncommonly the disease gradually develops into ordinary white swelling with destruction of the joint (see White Swelling).

Treatment of Serous Synovitis.—The treatment of serous synovitis depends partly on the severity of the symptoms, and partly on the cause of the disease. If a joint have been injured subcutaneously, and synovitis be apprehended, or indeed have commenced, no treatment will be found more efficacious than the continued application of ice in india-rubber bags of sufficient size to envelop the whole of the articulation; the limb being, of course, kept at the same time perfectly at rest on a splint or in a sling. Should the disease have made progress, or should the ice fail in arresting it, then, if the patient be young and strong, the application of leeches, followed by fomentations and accompanied by perfect rest of the part on a splint, or on pillows properly arranged, will be the most useful treatment. At the same time, saline purgatives may be given, and the patient kept on a low diet.

If the disease be *rheumatic*, hot fomentations may be applied, and rest of the part maintained in the elevated position; at the same time salicylate of soda may be given in ten-grain doses, and Dover's powder should be administered if there be much pain at night. If the patient be gouty, colchicum should be given. When the disease is of *syphilitic* origin, the application of blisters, followed by calomel and opium, will be attended with marked success.

In *subacute* or *chronic synovitis* rest is, perhaps, the most important element in the treatment, everything else proving nugatory unless this be attended to; the limb may be fixed by leather splints, or a starched bandage cut up so that it may be removed to make the necessary applications to the joint. In these cases the uniform pressure obtained by the application of an india-rubber bandage combined with rest will often cause the absorption of the effused fluid. Should this fail, repeated painting with tincture of iodine till the skin is slightly sore or blistering over the whole of the joint constitute perhaps the most useful local means that we possess. In a more advanced stage, counter-irritation by means of stimulating embrocations, together with douches, either of warm sea-water or of some of the sulphurous springs, such as those of Aix or Barèges, will prove most useful; and when all inflammation has been subdued, and weakness of the joint merely is left, the joint should be properly strapped with soap-plaster, spread upon leather, or supported by a well-fitting elastic cap or stocking. Amongst the internal remedies likely to be of most service, may be mentioned the iodide of potassium, either alone or in some bitter infusion.

In *hydrarthrosis* the treatment must necessarily vary with the cause. If it is apparently simple, merely an exaggeration of ordinary chronic serous synovitis, rest combined with the employment of pressure, iodine and blisters must be employed as in chronic synovitis. The internal administration of iodide of potassium, or a mild mercurial course, will sometimes induce the absorption of the fluid. If these means fail, the fluid may be removed by means of the aspirator, after which pressure may be applied by means of the india-rubber bandage to prevent its reaccumulation.

In extreme cases, Jobert, Velpeau, and Bonnet, recommended the injection of the joint with tincture of iodine, diluted with two or three parts of water. In performing this operation a small trochar is introduced into the joint, a moderate quantity of the serous fluid is let out, but not all, and then a corresponding quantity of the iodine solution is thrown in; and after being left for a few minutes, is allowed to escape. Inflammation of the joint, which is a necessary result of this procedure, comes on. This is treated by ordinary means, and, according to the statements of the French Surgeons, has in no case been followed by any serious consequences, but in several instances a complete cure without ankylosis has resulted. This mode of treatment does not appear to have met with much support in this country; yet it certainly deserves a trial, though recourse should not lightly be had to it, as it is evident that the induced inflammation might exceed the expected limits. In one case of hydrarthrosis of the knee, in an old man, in which I employed it, about six ounces of thin synovia were drawn off, and a drachm of strong tincture of iodine was injected into the joint. Slight inflammation only ensued; and the disease, which was of two years' standing, was completely cured. The chief points that appear to require attention are that no inflammation be going on at the time, there being no tenderness or pain in moving the joint, the effusion being quite passive, and of a very chronic character; and, above all, that no air be allowed to enter with the injected fluid. This treatment might be of service in the simple or tubercular form of hydrarthrosis, but if the case is one of Charcot's disease it could only do harm. If other methods of treatment fail, the joint may be drained by means of an india-rubber tube inserted with all antiseptic precautions. It may be retained for ten days or a fortnight, the dressing throughout being strictly antiseptic. After dropsy of the joint has been removed, the articulation is usually left weak for some length of time, in consequence of the stretching to which its ligaments have been subjected ; here cold douches and an elastic bandage will constitute the best mode of treatment.

In cases of tubercular dropsy of a joint with evident thickening of the synovial membrane, König recommends a free incision with removal of a slice of the diseased membrane on each side. The operation in his hands has been attended with satisfactory results, a movable joint being obtained. It must, of course, be performed with the strictest antiseptic precautions.

ACUTE ARTHRITIS.

By *Acute Arthritis* is meant an acute inflammation affecting the synovial membrane and rapidly extending from it to the other structures that enter into the formation of a joint. The disease may arise primarily in the synovial membrane, or the affection of the synovial membrane may be secondary to disease beginning in the bones or in the soft parts around the joint. In the latter case, the symptoms characteristic of acute arthritis do not set in until the mischief has extended to the cavity of the joint. In some forms of acute arthritis the symptoms clearly indicate that the inflammation of the synovial membrane precedes that of the ligaments, while in others the extension is so rapid that all the structures of the joint may seem to be affected simultaneously.

It will be most convenient to describe first the symptoms and pathological changes which are characteristic of acute arthritis from whatever cause it may arise, and afterwards to point out the modifications of the process dependent upon its mode of origin.

Symptoms.—The symptoms of acute arthritis that are most marked are the pain, heat, swelling, and peculiar position of the joint. The *pain* is often severe, tensive, and throbbing : so acute is it sometimes, that the patient screams with agony ; he cannot bear the bed to be touched, the room to be shaken, or the slightest movement communicated to the limb, any attempt at examination of the joint in such cases being attended with insupportable agony. There are usually nocturnal exacerbations, and the pain is commonly referred with especial severity to one particular spot in the joint : thus it is generally felt at the inner or under side of the knee-joint, and at the outer aspect of the hip. The *heat* of the diseased joint is considerable, and is often accompanied by more or less superficial redness. The *swelling* is uniform, involving the whole of the articulation, and not projecting at certain parts of it, as when the synovial membrane alone is affected ; it is generally not very considerable, and has a soft and doughy, rather than a fluctuating feel. The *position* of the affected limb is peculiar, and that attitude is involuntarily adopted in which the patient will have the greatest amount of ease : thus, if the knee is affected, it is semi-flexed, and the limb is rotated outwards ; if the hip, the joint is flexed and the limb abducted and rotated outwards with the knee semi-flexed ; if the elbow, it is bent. *Spasms* or *startings* of the limb, often of a very sharp and painful character, come on at times ; more particularly at night. Amongst the most distressing symptoms in the more advanced stages of acute disorganization of a joint are the painful startings of the limb. Whenever the patient falls asleep, the muscles becoming relaxed, the softened ligaments allow the joint to become slightly displaced; a reflex contraction of the muscles immediately takes place and the patient wakes with a painful spasmodic jerk of the limb, inducing a feeling of alarm, that is often very distressing. The *constitutional disturbance* is very severe, and of an actively febrile type.

Having reached this stage, in some cases the symptoms gradually subside, the heat lessens, the pain loses its acute character, the swelling slowly diminishes, and recovery takes place after many weeks or months, the joint being left permanently stiffened from contraction of the inflamed ligaments, or sometimes firmly ankylosed, the articular surfaces being united by dense fibrous tissue or bone, according as the cartilages have been partially or completely destroyed during the acute stage.

More commonly as the disease progresses, *suppuration* takes place within the joint, which becomes hot and red, with a good deal of throbbing pain; the skin covering it is œdematous, and at last fluctuation is perceived where the coverings are thinned. In some cases the suppuration occurs with very great rapidity, and partial or complete luxation of the joint takes place. In other cases the synovial membrane and capsule of the joint give way without any looseness of ligaments or displacement of bones, pus becomes infiltrated into the areolar tissue around the joint, an abscess forms external to the articulation, and extensive purulent collections become diffused through the limb. As the joint becomes loosened by the destruction of its ligaments, the bones become mobile, and grate against one another where the incrusting cartilage has been removed, thus giving rise to very severe suffering. The cartilages may, however, in some cases be very extensively destroyed, and yet no grating take place; this is owing either to the destruction being limited to the edge of the encrusting cartilage, the opposed surfaces being sound, or else to the interior of the articulation being filled up with granulation-tissue after the removal of the cartilages. But though abscess, either within the joint or external to it, usually forms when the bones grate and the cartilage disintegrates, yet it occasionally happens that these conditions exist—the symptoms indicative of erosion of cartilage, such as painful startings of the limb, grating, and preternatural mobility of the joint, being present—and yet no abscess forms; all the symptoms subsiding under proper treatment, and the joint recovering, though with a certain degree of ankylosis. But the reverse also may occur. Suppuration may take place in a joint, the synovial membrane and the capsule may give way, extensive filtration of pus into the deep areolar planes of the limb may occur, and yet no laxity of ligament, no preternatural mobility of the bones, no grating of the osseous surface, indicate the disorganization of the articulation which is in progress. This condition may occur in any joint; I have most frequently met with it in the knee. There the upper and usually the outer part of the capsule generally gives way, and the pus diffuses itself deeply beneath the extensor muscles of the thigh, sometimes even between the periosteum and the bone. In these cases the thigh swells greatly, the limb becomes œdematous, and a deep and obscure sensation of fluctuation may perhaps be felt, more especially towards the outer and lower part of the limb just above the knee. The swelling of the joint has perhaps subsided on the escape of the pus from the cavity, giving a false idea of security, which is confirmed by the absence of signs indicative of disorganization, such as lateral mobility and grating. But on pressing the thigh downwards, the joint will be found to fill, the patella will float again, and there is an evident communication between the synovial cavity and the extensive diffused abscess in the thigh. In cases of this kind the pus will first come to the surface about two or three inches above and to the outer side of the joint; and, on a free incision being made here, immense quantities may be let out. In these cases fluctuation is often masked by the œdema of the limb, and by the thickness of the overlying mass of muscle, and will require the closest examination for its detection. After suppuration has taken place, the constitutional disturbance partakes of the irritative type, the patient suffering severe pain, and being worn out by want of rest. After the abscess is opened, unless special means are taken by drainage and antiseptics to prevent the accumulation of decomposing discharges in the articular cavity, septic poisoning or pyæmia are very likely to follow ; or hectic leading to death from exhaustion and irritation may occur, unless the diseased part be removed. In other and less severe cases it falls into a state of chronic thickening, perhaps with fistulous openings leading down to the diseased structures; and in some of the more favourable instances the patient may recover, with a permanently rigid joint.

The *muscles* in the neighbourhood of an inflamed joint undergo a species of acute atrophy. In some cases the muscular changes are more than atrophic, and *Reflex paralysis of the muscles of a limb*, consequent upon inflammation of a joint, is occasionally met with. I have seen this singular affection in the extensor muscles of the thigh and in the muscles of the scapula, in cases of acute arthritis. In these cases the affected muscles rapidly waste. The wasting is not due to disuse alone, for it affects certain groups of muscles only, others which are equally inactive not being atrophied. But not only do certain groups of muscles in the affected limb become wasted, as for instance the extensors of the thigh or those passing from the scapula to the humerus, whilst the other muscular structures of the limb preserve their normal conditions, but another change takes place in them. They lose their electric irritability, and in fact become perfectly paralyzed. In the lower extremity the leg cannot be extended, in the upper the arm cannot be raised. This condition is extremely chronic. It will last for many months after the joint-affection, from which it starts, has been cured, and may lead to permanent atrophy of the paralyzed muscles. The treatment consists in stimulation of the affected muscles, by sea-douches, electricity, and frictions, combined with methodical movements of the limb. Strychnine may be given with advantage when the lower limbs are affected. I have seen this reflex arthritic paralysis chiefly in persons suffering from spinal exhaustion in neurotic women and in men addicted to sexual excesses.

Diagnosis.—*Abscess* may form external to, but in immediate contact with the capsule of a joint, and closely simulate disease of the articulation. In these cases the absence of serious constitutional disturbance, the irregularity of the swelling, greater on one side than the other, its extension over bony points, as the patella or olecranon, the superficial character of the fluctuation, the absence of all rigidity about the joint or of that preternatural mobility in a horizontal direction which arises from softening of the ligaments, and of other severe local symptoms, such as pain, starting, looseness, or grating, will enable the Surgeon to make a correct diagnosis.

Pathology.—It is very rarely that the opportunity arises of examining a joint affected with acute arthritis before it has reached the stage of suppuration. In that stage all the component parts of the joint will be found to present marked changes, varying somewhat with the cause and the degree of acuteness of the inflammatory process. The following may be taken as the appearances in a typical case.

The *synovial membrane* is thickened and intensely injected ; if the disease has advanced beyond the earliest stage, the membrane is no longer recognizable as such, being converted into a layer of granulation-tissue, the site of the fringes being marked by fleshy vascular projections of the same tissue. The granulations are seldom healthy ; most commonly they present the same appearance as those on the surface of an inflamed ulcer of the leg, being covered by a dirty yellowish layer composed of degenerated granulation-cells held together by coagulated inflammatory exudation. If the joint has been opened, and decomposition of the discharges has taken place, the diseased synovial membrane may be covered by opaque membranous patches almost resembling a diphtheritic membrane. In the later stages of arthritis, the granulations covering the opposed surfaces of any pouches of the synovial membrane will be found to have coalesced, the cavity of the joint being in this way to a great extent obliterated.

Microscopic examination of the diseased membrane shows only the ordinary appearances of inflammation. The endothelial cells covering the membrane have disappeared, the fibrous layer is first infiltrated with new cells before which the original tissue more or less completely disappears. In the layer of round cells thus formed, new vessels are developed, and granulation-tissue is thus produced.

The contents of the synovial cavity are in the very earliest stages composed of thin pus mixed with synovia, but as the membrane very soon ceases to yield its normal secretion, the fluid assumes the characters of ordinary pus. In cases in which the disease stops short of suppuration, an abundant coagulable fibrinous exudation is said to have been observed.

The ligaments are early affected by extension of the inflammation to them from the synovial membrane. The bundles of fibres are at first separated from each other by a coagulable inflammatory exudation, and the ligaments thus become swollen, and present at first a waxy or semi-gelatinous appearance. As the disease progresses the fibres become softened, and the ligaments yield, allowing the osseous surfaces to be displaced by the tonic contraction of the muscles, or the weight of the limb. The inflammation extends from the ligaments to the *periosteum of the articular ends of the bones* entering into the joint. The periostitis thus set up usually assumes the osteoplastic form (p. 262), and irregular masses of new bone, often arranged in jagged stalactite-like processes, are formed in the neighbourhood of the articulation. This is more marked in the less acute forms of the disease, or when after the escape of pus from the joint, the process has become chronic.

The *soft parts in contact with the ligaments* are œdematous in the early stages, but subsequently as the disease advances, they may become fused with the capsule of the joint, so that it is impossible accurately to separate them.

Abscesses not unfrequently form outside the joint, having no direct communication with its cavity.

The cartilages covering the articular ends of the bones in all cases present most important changes. These are never primary ; in every case it will be found that the morbid process proceeds either from the articular surface, or from the bone beneath. When the latter is the case, the affection of the cartilage is antecedent to the acute arthritis ; this condition commencing when the cartilage is perforated, and the joint becomes infected by the products of the disease which has commenced in the bone.

When the cartilage is affected in consequence of acute suppurative inflammation of the joint, the first change observed is a loss of its natural smoothness and polish. Its bluish-white tint becomes more opaque, and often assumes a slightly yellowish tinge. This is followed by loss of substance in those parts at which the opposed articular surfaces are in contact in the fixed position assumed by the inflamed joint. Finally the cartilage is completely destroyed at these parts, and the cancellous tissue of the head of the bone is exposed. As soon as perforation takes place, the suppuration extends between the cartilage and the bone, the pus being formed from the vascular medullary tissue of the cancellous spaces. The cartilage thus becomes loosened, and is bathed by pus on each side. Its nutrition being cut off it perishes, becomes yellow in colour, and tough and leathery in consistence. Microscopic examination shows that the process is one of sloughing and disintegration. The matrix is opaque and granular, and the cells show no signs of proliferation, but on the contrary have broken down into a mass of fat granules.

At the margins of the cartilages in those parts not exposed to pressure, and in those cases of acute arthritis which terminate without suppuration, the destruction of the cartilages takes place by a process of true ulceration. The cartilages are overlapped at their margins by the granulation-tissue formed from the inflamed synovial membrane. On removing this the surface of the cartilage will be seen to be marked by irregular hollows filled with a similar tissue, and in a later stage the cartilaginous tissue will be found to have been destroyed to a greater or less extent. In other parts of the cartilage similar changes may be observed, but they are always most marked in the neighbourhood of the vascular fringes of the synovial membrane. So much is this the case that Aston Key was led to believe that the destruction of the cartilage was directly effected by the development of a fimbriated or fringed vascular network or tissue from the synovial membrane, by which the process of absorption was carried out. The true nature of the changes occurring in ulceration of cartilage was first described by Goodsir, and his observations were confirmed and extended subsequently by Redfern and Rainey, who pointed out the fact that cartilage, like other extravascular tissues, may undergo changes independent of the prolongation of vessels into it. If a vertical section be made of a piece of articular cartilage in process of ulceration, the changes observed will vary with the acuteness of the process. In some cases the appearances will closely resemble those already described as being met with in ulceration of bone. The surface of the cartilage is seen to be irregularly hollowed out, the hollows being filled with small round cells, having the ordinary appearance of the migrating leucocytes observed in acute inflammations elsewhere ; immediately beneath these, the matrix of the unaltered cartilage is cloudy, and the cartilage-cells may be granular, but there is no evidence of proliferation. There is, in fact, nothing to prove that the new cells are derived from the pre-existing cells of the cartilage, and that the process is not exactly analogous to the destruction of bone by cells derived from the vascular medullary tissue, probably by migration from its vessels.

In less acute processes, on the other hand, the destruction of the cartilage is undoubtedly due to changes commencing in its own cells. In a vertical section proceeding from the healthy cartilage to the diseased surface, the following appearances are observed. In from the fifth to the twelfth layer from the surface the cells are seen to be undergoing proliferation ; in each capsule two to four cells are found ; proceeding towards the diseased surface, the number of cells in each space increases, and they gradually lose the characteristic appearance of cartilage-cells and become indistinguishable from the round cells of granulation-tissue. As the cells multiply the space containing them necessarily increases at the expense of the surrounding matrix, and at the same time the capsule becomes more and more indistinct and at last disappears altogether. The matrix near the surface becomes cloudy and granular, and at last completely disappears before the enlarging cell-spaces, which then coalesce, and thus there is formed on the surface a layer composed entirely of small round cells identical in appearance with those of ordinary granulation-tissue. The homogeneous intercellular substance may then soften and the cells may be cast off into the joint as pus-cells ; or should the disease tend towards recovery, new vessels may penetrate the groups of cells, proceeding from the nearest vascular tissue, and thus a vascular granulation-tissue may be formed, which will take part in the processes of repair to be subsequently described.

In order to distinguish these three processes from each other, we may term the first, necrosis with disintegration, the second, ulceration without proliferation, and the third, ulceration with proliferation.

The *bones*, when exposed by destruction of the cartilages, become affected more or less deeply by the inflammatory process. The changes that occur need no description, as they are identical with those already described in the Chapter on Inflammatory Processes in Bone. They usually assume the form of rarefactive osteitis with suppuration, or simple caries, but if the process be very acute, the inflammatory products in the cancellous spaces may break down into pus before the bony trabeculæ have been completely absorbed, and thus portions of the cancellous bone may be cut off from their nutrition and perish, forming sequestra (caries necrotica). In other cases the inflammation in the cancellous spaces may spread rapidly, and diffuse osteomyelitis be set up. This is especially prone to happen when the original inflammation in the joint is septic or infective in character.

CAUSES AND VARIETIES OF ACUTE ARTHRITIS.—Acute arthritis arises from many different causes, and the course of the disease varies somewhat according to its mode of origin. The following are the chief forms met with in practice :—

Acute Traumatic Arthritis, or Septic Arthritis.—This arises as a consequence of a penetrating wound of a joint, with admission of impure air and subsequent decomposition of the discharges. It rapidly terminates in suppuration, and in many cases leads to complete destruction of the articulation. It has been fully described with Injuries of Joints (Vol. I., p. 509).

Acute Infective Arthritis.—Acute inflammation of one or more joints is a common local effect of more than one general infective process. It is met with in pyæmia arising from wounds, in puerperal fever, scarlet fever, small-pox, and sometimes after typhoid fever. These are probably closely allied if not identical conditions, the general infection taking place from the placental surface in puerperal fever, from the ulcerated throat in scarlet fever, from the pustules in small-pox, and from the ulcers in the intestines in typhoid fever, just as, in ordinary pyæmia, it takes place from the unhealthy wound. Pyæmic arthritis begins suddenly, with very acute superficial pain. It differs from many other forms of acute arthritis in the rapid effusion into the joint which occurs at the commencement of the attack. It thus resembles simple acute synovitis in giving rise to a swelling, which at first assumes the outline of the distended synovial membrane. If the patient die at this stage, the joint will be found to have undergone but little change, the synovial membrane is injected, and the fringes swollen, and the cavity of the articulation contains a quantity of thin pus mixed with synovia. If the patient, however, survive more than a few days after the joint has become affected, the inflammation extends to the ligaments, destruction of the cartilages commences, and the case then runs the ordinary course of acute arthritis. It is sometimes possible to arrest the progress of the inflammation before the destructive changes set in, by early opening, free drainage and antiseptic treatment, but even then considerable thickening and contraction of the capsule usually result, leaving the joint more or less fixed. If the joint be opened without sufficient drainage and without antiseptic treatment, decomposition of the pus in the cavity takes place, and the ordinary results of septic arthritis follow. The exact process by which the joint becomes infected, and what it is that determines the particular joint or joints which are attacked, is not certainly known. The pus contained in the articulation in all forms of infective arthritis is very irritating and contains micrococci in large numbers. (See also Pyæmia, Vol. I., p. 980.)

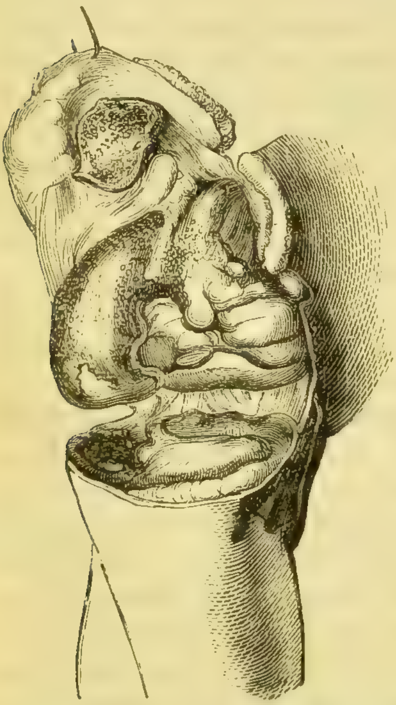


Fig. 535.—Interior of Knee disorganized by Acute Pyæmic Inflammation.

After scarlet fever it is not uncommon for the patient to suffer from slight swelling and pain in the joints resembling rheumatism. This "scarlatinal rheumatism" subsides without suppuration, and is probably distinct from the pyæmic affection just described.

Acute arthritis may also occur as a complication of gonorrhœa, but this is rare. The milder forms of inflammation of the joints, included under the term gonorrhœal rheumatism, will be described in the Chapter on Gonorrhœa. When the affection assumes a destructive form it is probably due to pyæmic infection.

Acute Arthritis from Exposure to Cold. Acute Rheumatic Arthritis.—This is a somewhat rare affection. After exposure to cold, especially from sleeping in the open air after being heated by violent exertion, the patient is seized suddenly with acute febrile symptoms, sometimes preceded by a rigor. At the same time swelling, with intense pain, commences in one joint, most commonly the knee. The symptoms at first so closely resemble an attack of acute rheumatism that these cases are commonly first admitted in hospital practice into the medical wards and subsequently transferred to the surgical. The distinction from acute rheumatism is made by observing the following points : the skin is hot and dry, the profuse sweating of rheumatic fever being absent ; the affection remains limited to the single joint attacked, and the local symptoms are more severe than in ordinary rheumatism. The ligaments are early implicated, and there is little recognizable effusion into the joint ; the pain is most agonizing and is of the character already described as occurring in acute arthritis. Pus may form in the joint in a few days from the commencement of the attack, but under proper treatment, the symptoms usually subside gradually, and the patient slowly recovers, after weeks or months, with the joint always stiffened, and usually firmly ankylosed, sometimes even by bone. The exact cause of the disease is not certain ; from its sudden invasion, and its arising from exposure to cold, it has been termed rheumatic, but the evidence of its being actually related to acute rheumatism is not clear. Volkmann describes it under the name of Acute Croupous Arthromeningitis, and states that it is characterized by an abundant coagulable exudation both into the synovial cavity and the soft structures forming the joint. From the facts that if suppuration takes place the cartilages are rapidly destroyed, and that in other cases bony ankylosis occurs subsequent probably to such destruction, Brodie and Mayo believed that structure to be primarily affected and named the disease Primary Acute Ulceration of Cartilage. At the present time ulceration of cartilage is believed to be invariably secondary to mischief commencing in the vascular structures.

Acute Arthritis secondary to Disease of the Bones.—Chronic diseases of the bones most commonly, when they extend to a neighbouring articulation, lead to a chronic disease of the joint, assuming the form of white swelling to be presently described. The only exception to this rule is the scrofulous abscess in the head of a long bone. This may perforate the cartilage, allowing its contents to enter the joint, and acute arthritis, ending rapidly in suppuration, may be set up. If the cavity has been already opened externally and contains decomposing pus, septic arthritis of the most acute form always follows perforation of the cartilage. The perforation of the cartilage in these cases is effected by a process of ulceration identical in character with that already described as occurring in acute arthritis commencing in the joint, the only difference being that it proceeds from the deep instead of the articular surface of the cartilage.

Acute inflammatory processes, when extending from the bone to the joint, always set up acute arthritis. Acute infective periostitis or osteomyelitis of the shaft (Acute Necrosis, p. 281), usually stops at the epiphyses, and consequently seldom causes disease of the neighbouring joints. Exceptional cases are, however, met with in which the articulations become affected. In these there is at first abundant effusion into the cavity of the synovial membrane ; this rapidly becomes purulent, and destruction of the cartilages and softening of the ligaments quickly follow.

Acute osteomyelitis attacking the growing bone in the epiphysis and usually terminating in its necrosis, or as it is termed *acute epiphysitis,* is a not uncommon cause of acute arthritis in young subjects. The causes of this affection are not always evident ; sometimes it is attributed to injury. On examining a joint affected in this way, the appearances already described as characteristic of acute arthritis with ulceration of the cartilages are met with. On making a section of the epiphysis from which the disease started, the bone contained in it will often be found forming a sequestrum bathed in pus, the cavity in which it lies communicating with the joint by an ulcerated track through the cartilage. In other cases the epiphysis may be separated from the shaft. Acute epiphysitis is probably in most cases an infective inflammation closely allied to acute infective periostitis, and osteomyelitis.

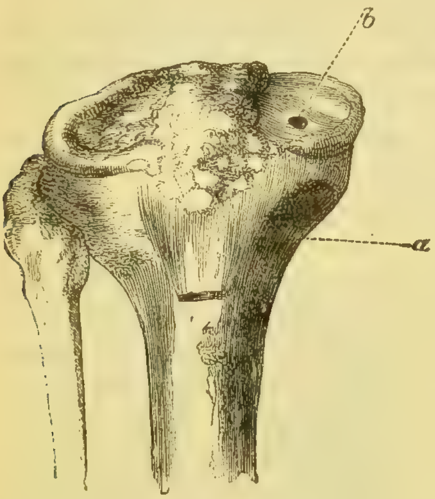


Fig. 536.—*a*, Caries at Head of Tibia. *b*, Perforation of Cartilage.

Syphilitic epiphysitis and its effects on the joints have been already described (Vol. I., p. 1161).

Acute Arthritis from Diseases of the Soft Parts external to the Joint.—Abscesses arising from any cause in immediate contact with a joint may burst into its cavity. When this happens, acute arthritis with destruction of the articulation invariably follows. This accident may occur in acute inflammation and suppuration of the bursæ in the neighbourhood of a joint. In phlegmonous erysipelas the joints are occasionally opened where the ligaments are in close contact with the subcutaneous tissue.

Acute Arthritis of Infants.—Under this name, T. Smith has described a form of acute arthritis unconnected with syphilis or injury, not uncommonly met with in very young children. It is sudden in onset, and runs a rapid course, ending in suppuration. It is most common in the knee, hip, and shoulder. The first symptom is restricted movement with pain, rapidly followed by swelling, and the formation of pus. In some cases two or three joints are affected. If the abscess is opened early, recovery may take place ; ankylosis rarely results, but more commonly a weak movable joint is left. The disease is fatal in a considerable proportion of cases. In the 21 cases recorded by T. Smith, the ages of the patients were as follows : 8 under 1 month, 4 under 2, 7 between 2 and 6, and 3 over 6 months. The *post-mortem* examination of the fatal cases showed rapid loss of substance in the articular end of one of the long bones entering into the joint. Acute Arthritis of Infants does not seem to be a separate disease. Some of the recorded cases were probably pyæmic arising in very young infants from infection from the umbilical cord ; others were instances of acute epiphysitis occurring in young children.

Senile Acute Arthritis.—There is occasionally but very rarely met with, a form of acute arthritis occurring independently of any external cause, but apparently due chiefly to simple loss of vitality in old persons of feeble constitution. I have seen it in the joints of the foot, the ankle, and the sterno-clavicular articulation. It resembles in this respect that form of senile necrosis of bones described at p. 292. In the senile arthritis now alluded to the pain is very acute, the enlargement of the joints considerable, the wasting of muscle rapid and great. The constitutional disturbance is proportionately severe. The joint that it most frequently affects is the knee. I have seen it also in the wrist. This form of arthritis must not be confounded with the dry rheumatic arthritis of old people. It differs from this form of the disease in the acuteness of its local symptoms, and the severity of the constitutional disturbance. It is often mistaken in the first instance for gout; but the rapidity of the process, the formation of pus within and around the joint, the necrosis of the contiguous bones, and the separation of the encrusting cartilages, all indicate the different nature of this affection; which, so far as the joint itself is concerned, is incurable, and which may terminate in the loss of the patient's life.

On examining the joint after removal, the cartilages will be found to be ulcerated, the synovial membrane softened, swollen and injected; the ligaments softened, and the osseous articular ends congested.

Repair.—Should the patient recover from acute arthritis without removal of the joint by amputation or excision, the process of repair will vary with the extent of the mischief done before the arrest of the disease. The inflamed ligaments seldom recover their normal condition. The inflammatory products with which they are infiltrated are partly absorbed, and partly developed into dense fibrous tissue. This process is accompanied frequently by some contraction, so that when it is completed the natural mobility of the joint is more or less interfered with. Should the position of the joint during the attack have led to relaxation of any ligament, as, for instance, of the ilio-femoral from flexion of the hip, the ligament becomes shortened as the joint recovers, so that the position assumed during the acute stage becomes a fixed one.

In the synovial membrane the inflamed surfaces, which have lost their endothelial covering and become covered with granulation-tissue, adhere to each other wherever they are in contact, and thus the synovial pouches become obliterated. If the cartilages have been but very superficially ulcerated, they may again become smooth without forming adhesions between the opposed surfaces. If, however, the destruction has gone on to the extent of the formation of granulation-tissue on the surface of the cartilages, the opposed granulating surfaces coalesce, the new tissue becomes developed into cicatricial fibrous tissue, and the joint is permanently stiffened. This condition is described as fibrous ankylosis. If the cartilage has been completely destroyed, the opposed granulations on surfaces of the bones coalesce and develop into bone, and thus osseous ankylosis results. In no circumstances does cartilage when once destroyed become regenerated.

Treatment.—In acute arthritis, perfect rest of the articulation is of the first moment. Unless this be secured, no other treatment can be of any avail. The limb should be fixed by some efficient apparatus and slung in a cradle. For the hip, knee, or ankle, Thomas's hip and knee splints will be found most useful. But not only is rest, amounting to absolute immobility of the joint, imperatively required as the first means of cure, but there is a second means which is almost of equal importance, with the view of removing pain, and preventing destructive disorganization of the articulation and consequent ankylosis,—I mean slight extension of the limb, so as to prevent the excessive and agonizing pain, that results partly from the pressure of one inflamed articular surface against the other by the tonic contraction of the muscles of the limb, partly from the spasms that shake the limb and body from time to time, when the patient falls to sleep. These pains are not relieved entirely by simple rest, more especially that pain which results from the spasmodic action of the muscles of the limb ; but they are usually at once removed by extension by means of a weight attached to the lower part of the limb. This is particularly the case in inflammations of the hip and knee joints. It is in these cases that the weight-extension apparatus, combined with perfect rest, is so advantageous. The weight should be proportioned to the age of the patient. Its use will often at once relieve pain, and enable the sufferer to procure sleep. Fomentations and ordinary topical soothing applications, such as a paint composed of equal parts of extract of belladonna and glycerine, may be combined with these means. In the acute stage of the disease, small doses of opium in pill may be useful, and at the same time the patient must be confined to liquid food without stimulants. Leeches applied freely to the joint frequently relieve the pain and diminish the acuteness of the symptoms, when the disease is not due to a septic or infective process.

Should these means be successful in arresting the progress of the disease before suppuration takes place, the inflammation often continues in a *subacute* form, and some modification must then be made in the treatment. In this condition rest, absolute and immovable, is equally imperative as in the acute stage, and may be secured in the same way. At the same time the joint may be repeatedly blistered ; but in many instances most benefit will be derived from the application of the actual cautery. This agent, when properly applied, yields much more certain and successful results than any other form of counter-irritation with which I am acquainted. The patient having been anæsthetized, a cauterizing iron, heated to a black-red heat, should be rapidly drawn over the diseased articulation in a series of parallel lines, across which an equal number of cross-bars are again drawn, so as not to destroy the whole thickness of the true skin. A good deal of inflammation is thus set up, followed by slight suppuration. When this has subsided, the application of the hot iron may, if necessary, be repeated ; in this way, the deep gnawing pain will usually be removed, and suppuration of the joint may be averted. For counter-irritants to be of any use, they must be employed before suppuration has set in ; it is only torturing the patient unnecessarily to have recourse to these agents when once pus has formed in the articulation. In order that full benefit should be derived from this plan of treatment, it must be persevered in steadily for a considerable length of time. The diet must consist chiefly of liquid nourishment during the acute febrile stage, but good food and stimulants will become necessary in proportion to the increase of the debility. As the inflammation about the joint subsides, a tonic plan of treatment on ordinary medical principles should be adopted.

During the subacute stage, if it be thought necessary to apply counter-irritation, absolute rest of the joints of the lower limb may be obtained, without confining the patient to bed, by the use of Thomas's hip or knee splint. (See Diseases of the Hip and Excision of the Knee.) If it be thought unnecessary to apply any counter-irritation, the inflamed joint may be efficiently steadied by the application of the starch or plaster bandage, the patient then being allowed to move about on crutches or in a chair. In disease of the joints of the foot, the patient may walk on a pin wooden leg resting on the bent knee.

With respect to the local treatment of the inflamed joint in the later stages of the disease when it has assumed a *chronic* form, it may be stated generally that so long as it is tender on pressure applied perpendicularly or laterally, so long as there is any loosening of the ligaments, or pain induced by movement, it must be kept absolutely at rest in splints or by a starch or plaster bandage. During this period great care must be taken to keep the joint in the position which will be most useful to the patient in after-life, should it become stiff; the straight one for the knee and hip, and the semiflexed for the elbow. In many cases it may be useful to strap the joint firmly, in the way recommended by Scott. This plan of treatment consists in spreading on pieces of lint the strong mercurial ointment, to every ounce of which a drachm of camphor has been added; strips of soap-plaster spread upon leather are then cut of a proper length and breadth, and the joint is firmly and accurately strapped up, the limb having previously been bandaged as high as the joint that is strapped. This dressing may be left on for a week or two, until it loosens or gives rise to irritation; over the whole a starched bandage may be applied. In many cases I have found it advantageous to strap up the joint with a plaster composed of equal parts of the emplastrum ammoniaci cum hydrargyro, and the emplastrum saponis or belladonnæ. These applications not only fix the joint and promote the absorption of the inflammatory products within and around it, but by acting as gentle counter-irritants, remove the remains of the inflammation that may be going on within it. If recovery have left the joint stiffened without being actually ankylosed, the natural movement must be restored by warm bathing, fomentation, friction, and passive motion. Warm water, in any way applied, is singularly useful in a way difficult of explanation in restoring the mobility of stiffened joints. Passive movement must be undertaken with great caution, and not until every trace of active inflammation has passed away. It is better to keep the limb fixed a month or more longer than is absolutely necessary than to begin passive movements a day too soon. The chances of ankylosis are only increased and the chronic inflammation prolonged by abandoning the treatment by perfect rest before the proper time.

Should the treatment fail to prevent suppuration, the prognosis becomes far more unfavourable, especially when large joints, such as the knee or hip, are affected; so, likewise, when the articular ends of the long bones are diseased, it is seldom that the joint can recover itself, as caries or necrosis is complicating the arthritis and keeping it up. When the articulation is very sinuous, as in the carpus, or when a number of small joints communicate with one another, if not directly by synovial membrane, at all events indirectly through the medium of ligament and of fibrous tissue, as in the tarsus, a cure can rarely be obtained. As soon as the presence of pus is recognized, steps must be taken to let it out completely, and to drain the cavity thoroughly. It is important that this should be done if possible before the capsule gives way and the pus becomes diffused in the surrounding parts.

When distinct fluctuation is felt and the cavity of the articulation is evidently full of fluid, if there be any doubt as to its nature, the joint should be punctured with the aspirator. If the fluid removed is thin serous pus mixed with synovia, the fomentations and other local means of treatment may be continued, and aspiration repeated if the joint fills again. If thick pus is withdrawn, an opening should be made at once and the cavity drained. If the skin is reddened at one part, under which fluctuation is very distinct, the presence of pus is certain, and aspiration will be of little use.

An abscess in a joint should be freely opened by one or two lateral incisions, extending fairly into the synovial cavity, so as to afford a free exit for the pus. The practice of making free incisions into a suppurating joint, as advocated by Gay, was a great improvement on the former method of merely puncturing it. The small aperture that was formerly made without any antiseptic precautions admitted air, in consequence of which the pus became offensive and irritating, and, being unable to escape freely, gave rise not only to much local mischief, but to severe septic fever. By laying the joint open freely, even when no special antiseptic treatment was adopted, much of this was prevented; exit was given freely to the pus through one or two incisions extending the whole length of the articulation; the septic poisoning from pent-up and putrid matter was prevented, and in many cases healthy granulations sprang up in the cavity and recovery took place with an ankylosed joint. The chances of this successful termination resulting are very greatly increased by the adoption of some efficient method of antiseptic dressing. The irregular cavity of a joint is difficult to drain perfectly even with the freest incisions, and consequently it is of great importance that such fluid as remains behind should not be allowed to decompose. The use of the carbolic spray, though not essential, will render the prevention of decomposition more easy and more certain. By the combined use of antiseptic drainage and rest most excellent results are obtained, and excision of the joint or amputation of the limb usually avoided. It is more especially in the knee, elbow, and hip, that this practice has yielded such good results. In some cases, even when the joint has been perfectly loose and grating, by perseverance in proper treatment a good and useful limb may be left. Should decomposition take place, profuse discharge followed by hectic or chronic septic poisoning come on, and pyæmia is not unfrequently developed; if the patient escape these dangers the joint may become useless or cumbersome, and its removal by amputation or excision must be practised. When an attempt is made to save the joint after suppuration has taken place, very special attention will be required, in consequence of the softening of the ligaments, to prevent displacement of the osseous surfaces either laterally or antero-posteriorly; this may be produced partly by the weight of the limb and partly by the traction of the muscles. Any neglect of proper precautions in the more minute details of the application and adjustment of proper apparatus may be followed by a very considerable amount of deformity. Should the joint already have assumed a faulty position, in consequence of the Surgeon neglecting to support it properly in splints in the early acute stage, the patient may be anæsthetized, and the limb gently placed in such a position as will be most conducive to his after-comfort.

With regard to the treatment of the special forms of acute arthritis, little need be said. That of *acute septic arthritis* from a wound has already been described. In *Pyæmic Arthritis*, most commonly little can be done owing to the constitutional condition of the patient, but should there be no visceral complications a cure not unfrequently results after free antiseptic incision, drainage, and rest. Ankylosis almost invariably ensues. In *Acute Arthritis from Cold*, perfect rest, leeches, and hot fomentations must be tried. Should suppuration take place, free incisions may be successful in saving the joint. In *Acute Arthritis secondary to disease of the bones*, the results of treatment are not very satisfactory. An attempt may be made to save the joint by removing sequestra and treating the carious surface as described in the Chapter on Diseases of Bones, but it often fails, and amputation or excision becomes necessary. In *Acute Arthritis of Infants*, the joint must be laid freely open as soon as pus forms, and by this means the limb can usually be saved. In *Senile Arthritis*, the treatment must be conducted on ordinary principles of rest, fomentations, opiates, and supports. But at last, in order to prevent destruction of life by pain and exhaustion, the question of amputation will arise; and, serious as this may be in old people, it will be the only alternative and chance of escape from a painful death.

CHRONIC STRUMOUS ARTHRITIS OR WHITE SWELLING.

White Swelling is a very chronic form of arthritis occurring in scrofulous subjects. It was described by Sir Benjamin Brodie under the name of **pulpy degeneration of the synovial membrane**. By modern German writers it is termed **fungous inflammation of joints,** and more recently, for reasons which will be stated hereafter, it has been proposed to call it **chronic tubercular arthritis**.

Symptoms.—The disease in many cases supervenes slowly on some slight injury, as a twist, or blow, or strain, but in others no definite cause can be assigned for its appearance, and the exact date of its commencement is often difficult to ascertain. It may commence as a chronic form of synovitis (see Chronic Synovitis, p. 328) in a strumous subject, assuming its peculiar characters at a later period. It is most frequently met with in children and females. The disease begins gradually with some pain and stiffness in the joint, causing a slight limp in walking if a joint in the lower limb is affected. The pain is increased after any extra exertion, and may then be severe enough to oblige the patient to rest for a day or two, when the symptoms usually subside. If the joint be examined during this stage, there will usually be found some slight limitation of movement, complete extension or flexion causing pain. If the joint be superficial, as the knee, elbow, or ankle, it will be seen to be swollen. The natural hollows are less clearly marked than in health, or even completely obliterated. The swelling at this stage takes the form of the distended synovial cavity, as in synovitis with effusion, but it does not give the same sense of fluctuation, being semi-elastic and pulpy. Sometimes, however, it is so soft that it is readily mistaken for fluid, even by the practised hand. In the knee it may be distinguished by observing that, though the patella is raised, it cannot be pushed down with a distinct concussion on the femur, as in synovitis with effusion. As the disease advances the joint becomes more enlarged, and as the ligaments become implicated the swelling loses the outline of the synovial membrane and assumes a more rounded form, the bony prominences being effaced by a uniform, doughy, semi-elastic or pulpy swelling. The integuments covering it preserve their white colour. There is usually but little pain felt when the limb is at rest, but motion becomes more and more painful, till it is no longer possible to use the limb. The position assumed by the limb at this time is that in which the patient has most ease, viz., that of semi-flexion, and with this there is a considerable degree of stiffness and rigidity. In this stage the inflammation commonly extends to the periosteum covering the articular ends, which become slightly enlarged by deposit of new bone from osteoplastic periostitis. The degree to which the articular ends are enlarged is very difficult to estimate, as they are usually obscured by the swelling of the surrounding soft parts, and in consequence of the wasting of the muscles from disease, the articulation appears more swollen that it really is. If the disease continues to progress, starting of the limb sets in at night, a symptom which is generally regarded as indicating that destructive changes are taking place in the cartilages. After these symptoms have persisted for a varying time the swelling becomes more prominent at one part, fluctuation becomes manifest, and the skin covering the prominent part gradually assumes a dusky red tint. Finally, if not anticipated by surgical interference, the abscess bursts, discharging unhealthy pus mixed with curdy masses. Before this takes place it may reach a considerable size and burrow for some distance from the articulation. The abscess does not necessarily occupy the whole cavity of the joint, for, as will be pointed out in describing the pathology of the disease, no cavity may exist by the time the abscess forms, the whole articular space being filled up with a mass of unhealthy granulation-tissue, in one part only of which the suppuration may have taken place. In other cases the abscess may form outside the joint, superficial to the ligaments. After the abscess has burst, its cavity may gradually contract and heal, but more commonly a sinuous track is left leading to the diseased joint. In other cases, especially if the abscess but incompletely empties itself, decomposition of the discharges sets in, the granulation-tissue filling the cavity of the joint may rapidly break down, and the disease then assumes the form of acute septic arthritis (p. 510, Vol. I.), with severe pain and rapid destruction of such cartilage as may have remained undestroyed at the time the chronic abscess burst. The limb swells and becomes œdematous, and other abscesses form around the joint. The ligaments become further softened, grating can be felt in the joint, and the articular surfaces become displaced.

The local phenomena of white swelling may thus be divided into three stages: first, that in which the disease is apparently limited chiefly to the synovial membrane and the swelling assumes the form of the synovial cavity; secondly, that in which the ligaments, cartilages, and articular ends of the bone become implicated, and the swelling becomes oval or rounded; and thirdly, the stage of suppuration.

The constitutional symptoms vary in the different stages of the disease. The general health does not appear to suffer in the first stage beyond some slight febrile disturbance during exacerbations from over-exertion of the joint. In the second stage also, the general health is but slightly impaired, except from want of exercise, and at the later period from want of rest if nocturnal startings set in. In the third stage there is progressive loss of strength. Even when the suppuration is very chronic there is usually some slight evening elevation of temperature, seldom, however, exceeding 101° F. After the abscess has burst, the constitutional symptoms become more severe, hectic may speedily set in, and tubercular disease of other organs, such as the lungs, may carry off the patient.

Pathology.—The pathological changes which are characteristic of the early stages of white swelling occur in the synovial membrane, and have been very accurately described by Billroth. The disease may commence primarily in the membrane itself, or this may be secondarily affected from a carious centre in the articular end of one of the bones entering into the joint ; but in whichever way it may commence, the changes characteristic of the disease do not develop till the synovial membrane is implicated. In the earliest stages that have been observed, the synovial fringes are swollen and the membrane is generally thicker than natural, and hyperæmic. There is, as a rule, no increase of secretion, but the synovia is often slightly turbid. I have once had the opportunity of examining a joint in this stage in a case of disease of the knee, in which, at the request of the physicians in attendance, I amputated at a very early period, in the hope of relieving very severe epilepsy from which the child was suffering. The appearances observed were exactly those described by Billroth, and were limited to the synovial membrane, the other structures entering into the articulation being apparently healthy. As the disease advances, the synovial membrane becomes thicker, and more vascular, its natural smooth surface is lost, and soft spongy granulations spring up upon it. This change is especially marked in the synovial fringes. These form soft masses of granulation-tissue which fill up the angles between the articular surfaces and gradually creep over the cartilages. Where two granulating synovial surfaces are in contact, as in the pouches of the knee-joint, they coalesce, and thus the cavity of the joint becomes gradually obliterated. It is in consequence of this limitation of the disease to the synovial membrane in the early stages, that the swelling of the joint, observed clinically, takes the form of the distended articular cavity, as in simple synovitis with effusion. As the disease advances, the chronic inflammation extends to the ligaments and capsule, which become infiltrated with the inflammatory products, and swollen and lardaceous in appearance ; and later on the areolar tissue surrounding the joint is similarly affected. It is owing to this that the swollen joint loses the form of the distended synovial membrane which characterized the earlier stages, and becomes rounded or oval. Simultaneously with the affection of the ligaments, the growth of the granulation-tissue within the joint continues until the synovial membrane may come to be represented by a soft pulpy mass of granulation-tissue from half an inch to nearly an inch in thickness. The growth gradually spreads over the cartilage, covering it like a veil. If an attempt be made to remove this it will be found that the advancing edge can be raised with the handle of the scalpel for about one-eighth of an inch, beyond which it will be adherent to the cartilage. The advance of the granulation-tissue over the cartilage is compared by Billroth to ivy creeping over a wall, and becoming gradually attached by its roots. If the granulation-tissue be scraped away, it will be seen that the cartilage is being gradually consumed, its place being occupied by the vascular new tissue. Finally, it is completely perforated, and the bone beneath becomes similarly affected. In the bone the process assumes the form of rarefying osteitis with exuberant growth of granulation-tissue (Superficial Fungating Caries, p. 286). The granulation-tissue spreading from the bone extends beneath the cartilage, loosening it from its attachment ; and, as now it is attacked on both sides, its destruction proceeds more rapidly than before. At the same time, the destructive process may extend to a varying depth into the cancellous tissue of the articular end of the bone. The periosteum usually shares in the disease, the inflammation assuming the osteoplastic form, and leading to the deposit of irregular masses of bone on the articular ends, chiefly in the immediate neighbourhood of the joint. At this stage no articular cavity remains ; the joint is represented merely by the articular ends of the bone more or less extensively denuded of cartilage, embedded in a soft pulpy mass of granulation-tissue, surrounded by the infiltrated and softened ligaments. When the granulation-tissue reaches the thickness of from a quarter to half an inch, its vascular supply becomes insufficient for its healthy nutrition, and fatty degeneration sets in in the parts most distant from the base of supply. It is from the appearance of the mass of unhealthy granulation-tissue that the disease received its name of "pulpy degeneration of the synovial membrane." The soft pulpy tissue is pink in colour, marked by yellowish patches of fatty degeneration and brown areas from old hæmorrhages. The fatty degeneration is followed sooner or later by softening, and thus a chronic abscess with flocculent curdy contents is formed. This frequently occurs in one or more local centres, without implicating the whole mass of granulation-tissue. Thus, in the knee, it frequently occurs in the synovial pouches above the joint.

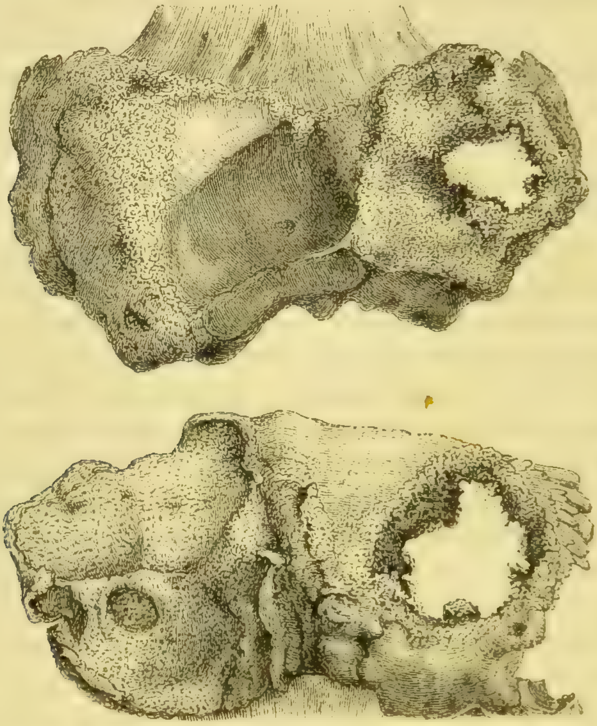


Fig. 537.—Bones from a case of tubercular disease of the knee-joint showing large wedge-shaped sequestra on the inner condyle of the femur and the corresponding surface of the tibia.

The disease does not, as before stated, necessarily commence in the synovial membrane; in fact, there can be no doubt that in a very large proportion of cases the membrane is secondarily affected from disease originating in the bones. It is only when the opportunity occurs of examining the joint at an early stage of the disease that it is possible to form any certain opinion as to the part in which it commenced. In the later stages, when the whole synovial membrane is replaced by a mass of pulpy granulation-tissue, and the cartilages are destroyed and the bones deeply affected, the evidence as to the point of origin is in most cases entirely destroyed. We can, then, only suspect that the bones were primarily affected when one articular surface is much more extensively diseased than the other, or when we find in one articular end a carious cavity, possibly containing a sequestrum of the cancellous tissue extending for some distance into the articular end of the bone.

If the opportunity arises of examining at an early stage a case in which the disease has commenced in the bone, the starting point will be found to be a centre of caries, either deeply seated in the cancellous tissue, as is commonly the case in the short bones of the tarsus, or immediately beneath the articular cartilage, or at the line of union with the epiphysis and the shaft in a long bone. By gradual extension of the carious cavity, the disease reaches the joint by perforating the articular cartilage, and as soon as this occurs infection of the synovial membrane takes place, accompanied by the phenomena just described, which soon completely conceal the primary affection in the bone.

The proportion of cases in which the synovial membrane is primarily affected has been differently estimated by different pathologists. König is of opinion that primary synovial disease does not form more than a quarter of all cases of white swelling. The frequency with which it occurs varies in different joints; thus it is more common in the knee than in the hip or elbow. Clinically it is, as a rule, impossible to distinguish accurately one form of the disease from the other.

On microscopic examination, the diseased structures present the following appearances. The ligaments show the ordinary changes observed in inflamed fibrous tissue. The fibres are separated from each other by inflammatory products, composed chiefly of small round cells. When the process is very chronic, new fibroid tissue may also be found. The cartilages show changes similar to those already described in acute arthritis. Before suppuration has taken place, ulceration both without and with evident proliferation may be present (see p. 336). The destructive changes may be observed on either surface, according as the disease commences in the synovial membrane or the bone. In the later stages, after perforation of the cartilage, both surfaces may be similarly affected. After suppuration has taken place, necrosis of cartilage with disintegration (p. 336) may also be met with. The bones present the appearances already described as being met with in fungating caries (p. 286). The chief interest attaches, however, to the microscopical appearances of the pulpy granulation-tissue which has replaced the synovial membrane and fills the cavity of the joint. The structure of this tissue has been made the subject of investigation by Köster, König, Volkmann, and Hueter, among others in Germany, and by Croft and Greenfield in this country, and all are substantially in agreement as to its nature. The chief bulk of the tissue is made up of small round cells, united by a structureless intercellular substance and abundantly supplied with vessels; in other words, of ordinary granulation-tissue. Scattered through this are numerous tubercle nodules, differing in no respect from those met within other structures (Vol. I., p. 1082). In other parts the granulation-tissue has undergone fatty degeneration and become reduced to a structureless granular mass. Croft and Greenfield pointed out that most commonly the diseased tissue may be divided into three layers, which merge into each other: first, the layer nearest the source of vascular supply (the bones or capsule of the joint), composed of ordinary granulation-tissue; secondly, a layer containing numerous giant-cells, surrounded by "epithelioid cells" and lymphoid corpuscles, arranged in the way ordinarily observed in nodules of tubercle, and forming non-vascular areas in the surrounding vascular granulation-tissue; and, thirdly, the layer most distant from the base of vascular supply, in which fatty degeneration is taking place, and all definite structure is lost. The tubercle nodules are not limited to the middle layer ; a few may be found in the first layer in the swollen ligaments and the medullary tisssue of the diseased cancellous tissue. The presence of this structure is so constant that it may be regarded as characteristic of true white swelling or strumous arthritis. In 72 cases examined by König it was found in 67, and in the remaining five the material for examination was deficient, so that no conclusion could be arrived at as to its presence. Croft and Greenfield and other observers agree as to the constancy of the presence of tubercle. The number of giant cells varies in different cases, but they are always present. Since the discovery of the tubercle bacillus by Koch, the presence of this organism in the pulpy tissue of white swelling has been frequently demonstrated. Further proof of the tubercular nature of the disease has been obtained by Hueter and others from inoculation experiments carried out on animals. The statistics of white swelling show moreover that in a very large proportion of fatal cases death takes place from general tuberculosis. Albrecht has published some statistics, in which it is shown that, out of 135 fatal cases, in 64 death occurred from tuberculosis.

At the present time, therefore, it may be said that the evidence of the tubercular nature of white swelling is practically conclusive. The starting point of the disease is probably in most cases some slight injury, the damaged tissues being subsequently invaded by the bacillus of tubercle.

Terminations.—White swelling resembles other tubercular diseases in its course and terminations. It may end in recovery by the development of fibrous tissue from the vascular granulation-tissue surrounding the tubercle, the actual nodules withering and remaining harmlessly embedded in the scar-like fibroid tissue, or the tubercular tissue may caseate and soften, giving rise to the formation of a chronic abscess, the tubercle being thus in some cases eliminated from the body. Calcification rarely if ever occurs in tubercular disease of the synovial membrane. The course taken by the disease depends partly on the constitutional state of the patient, partly on the hygienic conditions by which he is surrounded and partly on the treatment he receives. Recovery may in most cases be hoped for if the constitution is generally sound, if the patient is well fed, well clothed, and can spend a great part of the day in the open air in a healthy place, and above all, if such treatment is adopted as to give perfect rest to the diseased joint. On the other hand, in extremely scrofulous subjects the disease will often progress to destruction of the joint in spite of favourable surroundings and good treatment, and the same result frequently follows amongst the poor of large cities owing to the unfavourable hygienic conditions in which they are placed. Lastly, unless by proper treatment perfect and prolonged rest is given to the diseased joint there is no hope of recovery, however favourable the other conditions may be.

Imperfect recovery, with a stiffened and deformed limb, may occur after complete destruction of the articulation, especially when as the result of dislocation the diseased surfaces are no longer exposed to the irritation caused by the friction of one against the other. This is not uncommon in the hip. In a considerable proportion of cases the patient perishes from tubercular disease of the lungs or general tuberculosis before recovery of the joint has taken place.

Duration.—Tubercular disease of joints usually runs a very chronic course.

In a case of genuine white swelling recovery can rarely be hoped for under six months, and most commonly treatment has to be maintained for twelve months, and sometimes for even two or three years.

Treatment.—In the treatment of white swelling we must bear in mind that we have to deal with a scrofulous disease, and must therefore follow the rules of *constitutional treatment* laid down in Chapter XXXV., Vol. I., without which the local treatment about to be described will often prove ineffectual.

In the *local treatment* in the early stage, our first object is to arrest the progress of the disease, and, if possible, to prevent the occurrence of suppuration. The one essential condition for this is that *the joint be put at perfect rest*, without which all other treatment will be futile. By perfect rest we mean that the joint shall be so fixed by some suitable apparatus that the slightest movement of the articular surfaces upon each other is impossible, and if it be in the lower extremity that the patient shall bear no weight upon the affected limb. In almost all cases it is necessary that this absolute rest should be maintained for at least six months, and in a very large proportion it must be prolonged for a year or more. The period of rest must not be shortened for fear of causing stiffness of the joint. Imperfect rest from defective apparatus, by prolonging the disease, is a much more frequent cause of permanent impairment of function than perfect rest however long maintained. So long as there is any tenderness, pain, or marked swelling, rest must be continued. It is better to err, if at all, on the side of too prolonged rest, as premature removal of the apparatus will certainly be followed by a relapse of the disease. As in most cases it is uncertain what degree of stiffness will be left after recovery, the joint must be fixed in that position which will leave the most useful limb should ankylosis occur. Thus the knee and hip must be fixed in the extended position, and the elbow flexed to a right angle. The apparatus used will necessarily vary with the joint affected. If it be the hip or knee that is diseased, the best splints are those invented by H. O. Thomas, of Liverpool, which will be described in the next chapter. If the ankle is diseased the joint should be fixed in a plaster-of-Paris bandage, and the patient may be allowed to move about, kneeling on a "pin leg," with a trough to support the limb below the knee. In the upper limb the affected joint may be fixed by leather or gutta percha splints or by the plaster or starched bandage.

Another mode of treatment which has been strongly advocated by many Surgeons is the so-called "*extension treatment*." This consists in attaching a weight to the limb on the distal side of the diseased joint by means of a cord running over a pulley, by which the articular surfaces are prevented from pressing upon each other. Various forms of apparatus acting by means of screws have been invented for different joints with the same object. Extension is most useful in the hip and knee, but it should be employed only as a temporary means. When the patient is suffering from an exacerbation of the disease, with acute suffering on the slightest movement and starting pains at night, nothing will give such immediate relief as a well applied extension apparatus. It is especially useful when the joint has become flexed or otherwise displaced, so as to make the application of a rigid apparatus unadvisable till the displacement is as far as possible corrected. Under the extension treatment the acute symptoms usually subside before long, when an ordinary fixed apparatus may be applied. Permanent extension through the whole course of the disease presents no advantage over simple rest as above described, and has the great disadvantage of being in most cases impracticable without confinement to bed.

As accessories to the essential treatment by rest, *Compression* and *Counter-irritation* have been frequently employed. Compression may be carried out by means of bandages, strapping or splints, but it is very doubtful if it produces any real effect in the early stages of the disease. Counter-irritation by means of repeated blisters was formerly much employed, but the good it does, if any, is not enough to compensate for the pain it occasions. In some cases the actual cautery does seem to be of essential service. The indications for its use are severe starting pains, especially at night, occurring in a case of chronic disease in the adult, without any evidence of suppuration having taken place in the joint. It must be applied as described on p. 342, and is often followed by immediate relief of the symptoms. Leeches are occasionally useful in relieving pain during an acute exacerbation of the disease from want of rest, but they must be used sparingly if at all. The external application of mercurial preparations, with a view of promoting absorption of the inflammatory products, is never productive of good, and is very often positively injurious from its constitutional effect. To sum up, it may be stated that in the early stages of white swelling most Surgeons are at the present time inclined to rely upon perfect rest alone as the local treatment, combined with proper attention to the general health.

If, in spite of treatment, the disease continues to advance, and the affected joint becomes more and more distended by pulpy granulation-tissue, either softening in parts into chronic abscesses or threatening soon to do so, operative interference becomes necessary. The operative procedures adopted in white swelling are three in number : Incision, Arthrectomy or Erasion, and Excision or Resection. It is needless to say that these should be undertaken with the strictest attention to antiseptic precautions, upon the success of which the result will to a great extent depend.

Incision consists merely in freely opening the joint by one or more incisions, so placed as to injure the neighbouring muscles and tendons as little as possible. The operation is thus performed. The limb must be first thoroughly cleaned with soap and hot water, and afterwards washed with perchloride of mercury solution (1 in 500), or carbolic lotion (1 in 20). It is then made bloodless if possible by Esmarch's bandage. The joint is then fully opened by one or more incisions placed, if possible, at the most dependent part of the articulation, and of sufficient length thoroughly to drain the cavity without necessitating the use of drainage-tubes. The wounds should be held open with blunt hooks, and any pulpy granulation-tissue that comes into view should be removed with forceps and scissors. In some cases an oval slice of the diseased membrane may advantageously be taken away. If the incisions have been so planned that no important vessel is wounded, the dressing may now be applied before removing the tourniquet. The following dressing has been found to succeed very well in a considerable number of cases at University College Hospital. The wounds are first dusted with iodoform, and then over each a strip of the "green protective" oiled silk dipped in carbolic lotion is applied in order to prevent scabbing. Over this is placed a piece of carbolic gauze wrung out of carbolic lotion (1 in 20), so that there may be a powerful chemical antiseptic next the wound during the period of early discharge. Over this is placed a pad some inches thick of absorbent salicylic or iodoform wool, reaching about a foot on each side of the joint, and secured by a bandage applied with moderate firmness. The splint necessary to fix the joint immovably is then applied, and the patient is replaced in bed with the limb elevated at a right angle to the body, and the tourniquet is then removed. At the end of twenty-four hours, when all fear of oozing is past, the limb may be brought down to the level of the body. If all goes well, the discharge soaks into the wool and dries, and the dressing may often be left untouched for a month or six weeks, at the end of which time the incisions will in most cases have healed. The indications for changing the dressing are pain, elevation of temperature, or the appearance of discharge from under it.

Incision is adapted to those cases in which the joint is permanently distended with a small quantity of fluid, and to those in which a chronic abscess has formed. In the latter case, the cavity of the abscess should be thoroughly scraped with a sharp spoon at the time of the operation. The good effect of incision is probably due to a great extent to the relief of tension, as the diseased tissue is not extensively removed during the operation. In many cases recovery takes place with a perfectly movable joint. It is very important, to ensure success, that the incisions should be sufficiently free.

Arthrectomy or Erasion of the Joint was first recommended by Volkmann as a substitute for excision. In this operation the diseased joint is laid freely open, and the tubercular synovial membrane is dissected away as completely as possible with a scalpel or scissors and forceps. At the same time, carious cavities may be scraped with a sharp spoon. After the operation the same treatment may be adopted as in incision. The operation is chiefly applicable to the ordinary white swelling of the knee occurring in children, and will be more fully described in the next chapter.

Excision of Joints for White Swelling is often required when the bones are extensively affected, and will be fully described in the next chapter. If all other means fail, **amputation** of the limb is the last resource ; but the cases in which this is necessary are gradually diminishing in number owing to the improvements in conservative surgery consequent upon the introduction of the antiseptic treatment of wounds. It is chiefly resorted to in those cases in which the constitutional condition of the patient renders any other means inapplicable.

In cases that recover without operation much *thickening and stiffness of the joint are left,* and measures may be adopted for removing these conditions, and restoring the flexibility of the articulation by frictions with somewhat stimulating and counter-irritant embrocations, and eventually its strength by douches of sea-water. The swelling and puffiness that are left, together with the weakness dependent on relaxation of the ligaments, are perhaps best remedied by the use of strapping ; but pressure should not be applied so long as there is evidence of active inflammation going on in the articulation, which it would certainly increase.

CHRONIC RHEUMATIC ARTHRITIS, RHEUMATOID ARTHRITIS, ARTHRITIS DEFORMANS.

By these terms is meant a chronic disease of the joints of a progressive character—painful, disabling, deforming, and incurable. This disease has long attracted the attention of physicians, and has been described as "rheumatic gout," "nodosity of joints," and "deforming arthritis," or osteo-arthritis. But little was really known of its true nature until its pathology was studied by Professor R. Adams and R. W. Smith of Dublin, who accurately described it under the name of "chronic rheumatic arthritis." More recently, Sir A. Garrod has added much to our knowledge of this disease, and has proposed for it the name of "rheumatoid arthritis." When it gives rise to much distortion of limb and deformity of joint, as often happens when the hands are chronically affected by it, the name of "arthritis deformans" is given to it.

This disease may attack any joint, and may continue limited to it, or may extend from one to the other until most of the larger articulations are involved. It commences usually in the joints of the limbs, and may be confined to them, or it may primarily attack the temporo-maxillary articulations or those of the spinal column. It occurs in both sexes with tolerably equal frequency. But some joints appear to be more liable in one sex than in the other. Thus the hip in the male, the knee in the female, is more commonly the seat of the malady.

Rheumatoid Arthritis is essentially a disease of middle age; when once it sets in it will continue for an indefinite period, far into old age.

Rheumatoid Arthritis may affect one or two joints symmetrically, especially when it occurs in persons otherwise healthy and past middle life. It is then usually confined to the larger articulations. In other cases it may attack a number of joints, including the smaller articulations, such as those of the fingers. This form is often termed *polyarticular rheumatoid arthritis*, to distinguish it from the more limited or *monarthritic* affection. It often leads to great deformity, and may entirely cripple the patient. It is met with sometimes at a comparatively early age, especially in anæmic females.

Chronic Rheumatoid Arthritis essentially consists in an organic change of structure in all the various component parts of the affected joint. The starting point of the disease appears in most cases to be the cartilage. The first change observed is a loss of polish and smoothness, gradually increasing till the surface becomes velvety in appearance. Microscopic examination shows that this change is due to the gradual conversion of the matrix into fibrous tissue, the fibrillæ of which are arranged at right angles to the surface. At the same time multiplication of the cartilage cells takes place, so that the capsules are found to contain an excess of cells, which, however, retain the appearance of cartilage cells. The cartilage so altered is gradually worn away by the friction of the diseased surfaces against each other, until the bone is exposed. When this takes place the exposed bone becomes increased in density by the formation of new osseous tissue filling up the cancellous spaces. The new tissue may be true bone with lacunæ, but in many cases it is excessively dense in structure, contains a great excess of lime-salts, and appears to be formed rather by calcification than by ossification of the medullary tissue of the cancellous spaces. The bony surfaces thus exposed are worn away, and greatly altered in shape by the friction of movement; at the same time they become highly polished, like ivory or porcelain—eburnated or porcelaneous as it is termed. In spite of the density of the structure thus formed, it is constantly being worn away by friction as long as motion is left in the joint, the next layer of cancellous tissue then undergoing the same change. These destructive processes commence and advance most rapidly in the central parts of the cartilages, and while they are in progress irregular cartilaginous outgrowths spring from the circumference, forming in many cases flange-like projections from the margins of the articular surfaces. These cartilaginous outgrowths are ossified at an early period, and thus form rounded irregular osteophytes, often reaching a very considerable size, and impeding or completely abolishing the movements of the joint. The osteophytes of rheumatoid arthritis differ essentially from those formed round a carious joint. Their form and appearance have been very aptly compared to the gutterings of a wax-candle, while the osteophytes round a carious joint have the jagged form of stalactites. The fact that the former are developed from cartilage and the latter from granulation-tissue, forms another distinction between them. Occasionally isolated nodules of ossifying cartilage of a flattened form are found in the subserous tissue beneath the synovial membrane. In the early stages the ligaments and synovial membrane show but little change ; but as the disease advances, the capsule of the joint becomes greatly thickened. The synovial membrane becomes opaque, and its fringes increased in size. In some cases this enlargement of the fringes is very considerable, the separate papillæ reaching a great size, sometimes even half an inch in length. When this condition is very marked the term *Villous Synovial Membrane* is applied to it. In the free extremities of the enlarged papillæ rounded or flattened nodules of cartilage may be formed. These sometimes become broken from their attachments, and form loose bodies in the joint.

In the earlier stages of rheumatoid arthritis there may be a slight excess of synovia which is turbid, but effusion never forms a marked feature of the disease, and hence the term *dry* is often applied to it.

A section of the bones entering into the affected joint shows that the cancellous tissue beneath the eburnated surface is more spongy than natural, the spaces being filled with yellow fat. In consequence of this atrophy of the bone, the shape often becomes considerably altered. This is most characteristically seen in the neck of the femur, which becomes shortened and set more at right angles with the shaft than natural.

Suppuration rarely occurs in rheumatoid arthritis. I have seen it only when the disease was developed at an earlier period of life than usual, at from thirty to forty, or when an injury occurred to the affected joint.

Symptoms.—The affected joint becomes partially ankylosed ; it is swollen, tender, deformed, and useless. It is the seat of constant pain with occasional exacerbations, often very severe and prolonged. The general health may continue fairly good, though life is rendered miserable by pain and decrepitude. One of the most marked features of the disease is the crackling felt on moving the joint. In the early stages this is soft, but as the cartilages become destroyed and the bones exposed, it becomes gradually harsher till it may almost resemble the crepitus of a broken bone. When the synovial membrane is villous, there is considerable fulness of the joint with a very fine soft crepitation in movement.

The **Causes** of rheumatoid arthritis are for the most part very obscure. Long continued exposure to damp cold, as prolonged residence in a damp house, or on a wet and clayey soil, undoubtedly predisposes to the disease, and in many cases appears to be the direct occasioning cause. The sprain of a joint will in many cases appear to be the local determining cause. The essential cause of the disease is unknown. It is not scrofula, it is not gout, it is not true rheumatism ; as Garrod truly observes, it is much easier to prove what rheumatoid arthritis is not, than to give the slightest clue to what it is. It is generally supposed to be dependent upon some form of malnutrition of the system, and to be predisposed to by depressing influences, physical or moral. That deficient or perverted innervation may in some manner lead to rheumatoid arthritis is not improbable, the more so when we consider that a somewhat analogous condition of joint has been described by Charcot as one of the characteristic phenomena of locomotor ataxy.

Treatment.—Little can be done to cure, but much to relieve and retard. Rest and strapping the joint in iodine or stimulating plasters will afford relief ; and, in many instances, the administration of the iodide of potassium will lessen the nocturnal pain. Smith recommends an electuary composed of guaiacum, sulphur, the bitartrate and carbonate of potash, and ginger, with a small quantity of rhubarb ; and I have certainly seen benefit result from the administration of this remedy in some cases. Ammoniacum and cod-liver oil are both extremely useful in some cases. When the disease is once fairly established, and has assumed a very chronic character, it will be found of great importance to give the affected joint as much rest as possible, without confining the patient to the couch or house. This is best effected by his wearing a proper supporting apparatus. When the hip or knee is the seat of the disease, the apparatus should consist of a firm leather pelvic band having a steel rod extending down the outside of the limb, hinged angularly opposite the hip, knee, and ankle, and fixed into a socket in the sole of the boot, and properly adjusted by means of straps and moulded leather to the thigh and leg. By the use of this apparatus the weight of the limb is taken off, and all rotatory movement of the hip is prevented, to-and-fro motion being allowed. Thomas' hip- or knee-splint will sometimes be found useful.

Mineral waters and baths are often beneficially used in the treatment of rheumatoid arthritis ; those of Wildbad and Franzenbad in Germany, of Aix-les-Bains in Savoy, Barèges and the other Pyrenean sulphurous waters in France, Buxton and Bath in this country. That warm douching and bathing may give great relief is undoubted. But that they can cure an organic joint-disease of the nature of rheumatoid arthritis is scarcely within the bounds of probability.

Chronic Rheumatoid Arthritis of the Hip.—This form of the disease commences with pain in and about the joint, increased at night, and especially in damp or cold weather, presenting in this respect the ordinary characters of a rheumatic affection ; as the disease advances, the pain, which is continuous, is much increased by standing or walking, and the movements of the joint become gradually more and more impaired. The patient experiences the greatest difficulty in bending the body forwards from the hips ; he consequently is unable to stoop, or to sit in the ordinary position, being obliged to keep the limb straightened in nearly a direct line with the trunk. The difficulty in walking, in standing erect, in stooping, and in sitting increases. The trochanter will be felt to be thickened. The limb becomes gradually shortened to the extent of about an inch or more, owing to changes that take place in the head and neck of the bone. The pelvis also assumes an oblique direction, and hence the apparent shortening becomes considerably greater. The knee and foot may either be inverted or everted, and the heel is raised. The shape of the hip also alters considerably ; it becomes flattened posteriorly, the gluteal muscles waste so that the fold of the nates diminishes and sinks to a lower level, but the trochanter projects, and on examination seems larger and thicker than natural (Fig. 538). On rotating the limb, the movements of the bone are extremely limited, and crackling, grating, or osseous crepitation will often be felt around the joint. As Smith remarks, the lumbar vertebræ acquire great mobility. The thigh on the affected side is wasted, but the calf retains its natural size and firmness.

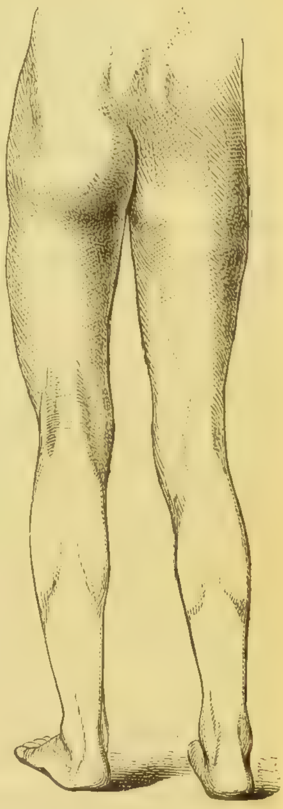


Fig. 538.—Chronic Rheumatoid Arthritis of Right Hip-joint.

Pathological Changes.—On examination after death, the changes already described as characteristic of rheumatoid arthritis will be found. The round ligament is destroyed, and the head of the bone is remarkably altered in shape, being flattened, greatly increased in size, or placed more or less at a right angle with the shaft, sometimes elongated, and always very irregular and tuberous. The neck is more or less absorbed, and in some cases appears as if it had undergone fracture. The acetabulum generally becomes enlarged, sometimes of a more or less circular and flattened shape; but in other cases projecting and narrowed at its rim, embracing tightly the head of the thigh-bone (Fig. 539). Both it and the upper part of the thigh-bone become porous, and perforated with numerous small foramina. Masses of bone are commonly thrown out about the base of the trochanter, but more particularly along the inter-trochanteric line within the capsule of the joint, and not unfrequently in the soft tissue around it. In many cases the apparent increase in the size of the head of the bone is dependent on the deposition of these masses of osseous tissue upon it, rather than on any expansion of the upper articular end of the thigh-bone. These masses of bone constitute one of the most important characters of the disease. The muscles and soft structures in the vicinity of the joint are necessarily wasted from disuse.

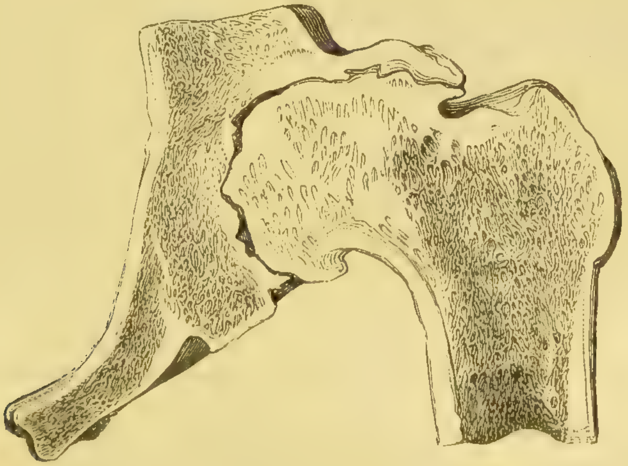


Fig. 539.—Section of Hip-joint affected by Dry Chronic Rheumatoid Arthritis

Diagnosis.—It occasionally happens that an individual labouring under this affection meeting with a fall or contusion on the hip, presents signs of *fracture of the neck of the thigh-bone*, such as shortening, eversion, with some crepitation perhaps, and inability to move the limb. The diagnosis may in general be readily made by attention to the history of the case, and by eliciting the fact that the symptoms have existed to some degree before the accident, although the pain and immobility may have been increased by it.

Chronic Rheumatoid Arthritis of the Lower Jaw.—Chronic rheumatoid arthritis has also been described by Smith as occasionally affecting the temporo-maxillary articulation in individuals of rather advanced age. This disease is often symmetrical, and gives rise to an enlargement of the condyle of the jaw, which can be felt under the zygoma, attended with much pain in opening the mouth, a sensation of cracking or grating in the joint, and some enlargement of the lymphatic glands by the side of the neck. The pain is generally increased at night, and influenced by the state of the weather. The face becomes distorted, the affected side of the jaw projecting and being pushed towards the opposite side ; but when both joints are affected, the chin projects, the entire jaw being drawn forwards. This distortion is chiefly owing to the destruction of the articular eminence : for, when this takes place, the external pterygoid muscle draws the jaw forwards and to the opposite side ; but when both articulations are equally affected, these muscles displace it directly forwards : the glenoid cavity becomes enlarged, the fibro-cartilage disappears, and the condyle is sometimes greatly thickened and flattened, and always rough, being devoid of cartilage. In such cases there is little to be done by medicines ; but the treatment must be conducted on the same principles as in the same affection attacking the hip.

Chronic Rheumatoid Arthritis of the Shoulder.—When it affects the shoulder, chronic rheumatoid arthritis gives rise to a considerable enlargement of the head of the humerus, wasting and rigidity of the deltoid, and inability to move the elbow upwards, except by the rotation of the scapula on the trunk. In fact the scapulo-humeral articulation being fixed, all movements of the shoulder are effected through the medium of the scapula, which becomes more mobile than natural. The articulation is the seat of much pain, lancinating at times, but generally gnawing and intermittent, being dependent on the state of the weather, and greatly increased in cold and wet seasons. The whole of the arm becomes wasted, and weakened in power. In two instances I have seen this disease in young and otherwise robust and healthy men, between twenty and thirty years of age, coming on without any apparent cause. In both cases the joint continued permanently rigid, though the pain was relieved by the use of the iodides and by local counter-irritation.

DISEASES OF JOINTS OF CEREBRAL OR SPINAL ORIGIN.

The so-called *arthropathies* occurring as the result of diseases of the central nervous system may be divided, according to Charcot, into two classes.

1. **Arthropathy of Paralysed Limbs.**—Acute or subacute inflammation with considerable swelling from effusion into the joint, and more or less severe pain, is occasionally observed in the articulations of limbs paralysed from acute or subacute inflammation of the spinal cord. Mitchell has observed

it in Paraplegia from Pott's disease ; Vignès, Joffroy, and Sir William Gull as the result of paralysis from traumatic lesion of the cord ; Scott, Alison, and others have also met with a similar affection of the joints in limbs paralysed from circumscribed cerebral softening, or intra-cephalic hæmorrhage. It comes on at the same time as the contraction of the muscles commences, usually fifteen days to a month after the paralysis has set in. It has no tendency to end in suppuration.

2. **Arthropathy of Ataxic Patients, or Charcot's Disease.**—This condition was first described by Charcot. It has recently been exhaustively investigated by a Committee of the Clinical Society of London, by whom a valuable report was published in 1887. The disease occurs in patients suffering from locomotor ataxy, setting in without apparent cause at various stages of the malady, either before or after the appearance of the ataxic symptoms in the limbs. Thus in 47 cases collected by the Committee above mentioned, in 10 the joint-lesion was situated in the upper extremity, and in only one of these were there any signs of want of co-ordination in the movements of the limb. In 37 the joints of the lower limb were affected, and in 20 of these there was no ataxy at the time when the disease appeared. The onset of the joint affection may be sudden or gradual. The sudden invasion is most characteristic, and occurs in more than two-thirds of the cases. It commences with a general and often enormous swelling of the limb, commonly without pain or fever. After a few days the general swelling disappears, but the joint remains distended with fluid. Sometimes the bursæ in the neighbourhood of the articulation are also distended. The fluid, if drawn off by the aspirator, quickly re-accumulates. It is perfectly transparent, and of a pale lemon colour. At the end of some weeks or months the swelling subsides, and the joint may return in exceptional cases nearly to its normal condition. In the more typical cases, however, crackling appears on movement within a few weeks of the commencement of the attack, the ligaments become relaxed as the effusion is absorbed, and the osseous surfaces are altered in form by rapidly wearing away. In this stage there is coarse rough grating in flexing or extending the joint, but these movements are unaccompanied by pain. Owing to the alteration in the bony surfaces and the relaxation of the ligaments, abnormal lateral movements, or a capability of over-extension, may be met with, giving rise to great unsteadiness in walking if the lower limb is affected. Dislocation of the diseased joint may occur, especially in the hip or shoulder. This may take place early as a consequence of extreme distension of the capsule during the stage of effusion, or at a later period as a result of the wearing away of the bones. The cases in which the disease sets in gradually more closely resemble chronic rheumatic arthritis in their course, being characterised by gradual enlargement with alteration in form of the ends of the bones accompanied by painless grating on movement. The accompanying figure (Fig. 540), well illustrates the appearances in both the early and late stages of Charcot's disease. The right elbow was attacked in 1885, after the patient, a man aged about 40, had suffered from symptoms of locomotor ataxy for two years. The joint became rapidly and painlessly distended with fluid. As this subsided, it was found that the bones of the forearm were partially dislocated inwards, and there was free lateral mobility in the joint. In 1887 the joint presented the appearance shown in the figure. It was much deformed by bony outgrowths, the dislocation remained as before, but the lateral mobility had disappeared. Flexion

and extension were painless but accompanied by coarse grating, and were slightly limited in extent. At the time the photograph was taken in 1887, the patient was suffering from an acute attack in the left elbow. The whole arm was enormously swollen, and in parts red and brawny, pitting under very firm pressure. There was a sensation of tightness of the skin, but no actual pain even when the joint was moved. There was coarse grating on moving the joint. The capsule was tensely distended with fluid. Two months after the swelling was gradually subsiding. In 1885 the patient suffered from a temporary attack of neuritis of the right musculo-spiral nerve with paralysis of the extensors of the wrist and fingers. An analysis of the 66 cases collected by the Committee of the Clinical Society showed that in 41 a single joint was affected, in 19 two joints, and in only 6 were more than two attacked. In the 66 cases 100 joints were affected in the following order of frequency: knees, 45; hips, 24; shoulders, 13; elbows, 7; tarsus, 5; metatarso-phalangeal joints, 4; wrist, 1; phalangeal joints, 1.

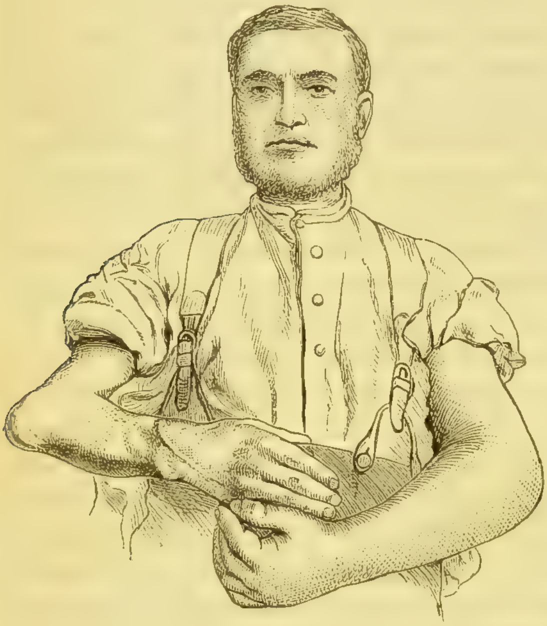


Fig. 540.—Charcot's Disease of both Elbows.

The *pathological appearances* found after death are similar to and in many cases identical with those already described as being met with in arthritis deformans (p. 353). The chief differences are, first, that the wearing away of the surfaces is often very extensive, and that the formation of ossifying cartilaginous outgrowths round the joint is very limited, or even wanting; and secondly, that true dislocations are common from relaxation of the ligaments, whereas in arthritis deformans they are rare, and when present are due, not to relaxation of the ligaments, but to pressure of the bony outgrowths. It has been suggested that Charcot's disease is merely arthritis deformans occurring in a patient suffering from locomotor ataxy, and that the wearing away of the bones is aggravated by the inco-ordinate movements of the limbs and the want of sensation in the joint. There seems, however, little reason to regard this as the true explanation of the disease, for it usually sets in before marked inco-ordination is present. It is further distinguished from osteitis deformans by its most commonly affecting a single joint, by its sudden invasion, by the abundant effusion commonly met with in the early stages, by the occasional retrogression of the disease, and by the abnormal lateral mobility, in all which points it is the exact reverse of rheumatoid arthritis. The Committee of the Clinical Society after careful inquiry failed to find any case presenting the characteristic features of Charcot's disease in which the symptoms of tabes dorsalis were completely wanting. For the description of this disease I must refer the reader to works on medicine. It must suffice here to mention that the chief symptoms to be looked for are loss of knee-jerk, loss of sexual power, occasional incontinence of urine, loss of reaction of the pupil to light while it still accommodates itself for near vision, want of co-ordination in the muscles of the limbs, inability to walk steadily with the eyes shut, lightning pains in the limbs and joints, occasional delayed or otherwise modified sensation in the limbs, and a history of the so-called "gastric crises."

The *Treatment* of the disease is very unsatisfactory. Nothing can be done to cure, but the limb may be sometimes made more useful, and the destructive processes delayed by properly fitted supports or splints. Aspiration is occasionally useful to relieve the distension of the joints, but its effect is merely temporary. Pressure is also ineffectual in preventing the early effusion into the joint.

ANKYLOSIS OR STIFF JOINT.

Ankylosis is invariably the result of partial or total destruction of a joint by inflammation, and is one of the modes by which nature effects its repair. It consists in the more or less complete consolidation of the parts around and within the articulation. It is of two kinds: the Incomplete, or Fibrous; and the Complete, or Osseous.

In the **Incomplete** or **Fibrous Ankylosis**, the stiffness of the joint may be dependent on four distinct pathological conditions which may be more or less associated :—1, on thickening and induration of its fibrous capsule; 2, on the formation of fibroid bands as the result of inflammation within the joint; 3, in consequence of the cartilages and synovial membrane being in part or wholly removed, and their place being supplied by a fibroid tissue, by which the articular ends are tied together; 4, on shortening of the ligaments on the side of flexion of the joint. The stiffness of the joint may be materially increased by the shortened and contracted state of the muscles around the joint, but this is secondary to, and not an essential part of, the ankylosis. Fibrous ankylosis commonly results from rheumatic or gonorrhœal or tubercular arthritis, and is the most favourable result that can be hoped for in many of these affections. In some cases it arises simply from disuse; the ligaments being shortened, and the limb becoming stiffened in the position in which it has been too long retained.

Complete or **Osseous Ankylosis** is of two kinds. In one, all the soft parts within the joint are destroyed, and the osseous surfaces have coalesced, or are fused together by direct bony union; this is most commonly seen in the hip (Fig. 541), knee, and elbow. In the other kind the bones are united partly by fibrous tissue, and partly by arches or bridges of osseous tissue thrown out externally to the articulation, and stretching across from one side to the other. In some very rare cases these bony masses may be formed partly by ossification of the ligaments. There is a specimen illustrating this in the Museum of University College. In it the knee is completely ankylosed in an over-extended position, and the ossified ligamentum patellæ is clearly to be recognized. Such cases are altogether exceptional; as a rule, from the irregularity of the bony masses it is evident that they are new formations. The true or osseous ankylosis does not often occur as a consequence of scrofulous articular inflammation, but is usually the result of pyæmic or traumatic inflammation in persons of a healthy constitution. It not unfrequently happens, in old standing cases of diseased joint, that more or less complete ankylosis is taking place at one part of the articulation, whilst caries, or necrosis of the bones, is going on at others. It is usually easy to make the *Diagnosis* between fibrous and osseous ankylosis; the joint being movable, though perhaps only to a very slight degree, in the former, whilst it is rigidly and immovably fixed in the latter. In fibrous ankylosis, moreover, any attempt to move the joint by force is usually accompanied by severe pain with involuntary contraction of the neighbouring muscles, whilst in osseous ankylosis such attempts, unless extremely forcible, are painless. Cases not unfrequently occur in which the rigidity of the structures, muscular and capsular, outside the joint, is so great in the fibrous, and the mobility of the neighbouring bones and joints so free in the osseous, that it becomes very difficult to decide to what degree the joint is stiffened. Here the diagnosis may be made by putting the patient under an anæsthetic, when if the ankylosis be fibrous, the joint will be found to yield.

Treatment.—The treatment of ankylosis is, in the first instance, of a precautionary nature; that is to say, when the Surgeon finds that the establishment of ankylosis is, as it were, the natural means of cure adopted by Nature in a deeply diseased joint, his efforts should be directed to taking care that the joint shall become fixed in such a position as will leave the most useful limb to the patient. Thus, if it be the hip or knee, the ankylosed joint should be in the straight position; if it be the elbow, it should be placed at a right angle, and the hand in the mid-state between pronation and supination.

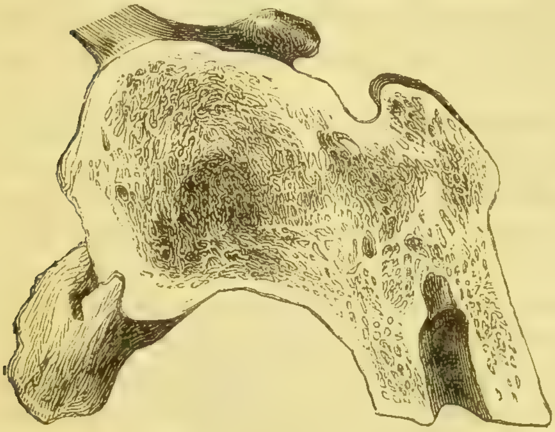


Fig. 541.—Osseous Ankylosis of Hip.

When once ankylosis has occurred, the treatment to be adopted will depend partly on the degree of stiffness, whether it be fibrous or osseous; and partly on the object to be attained, whether this be merely the restoration of mobility in a part ankylosed in a good position, or the remedying of the deformity occasioned by faulty ankylosis.

1. In attempting to restore the mobility of a joint ankylosed in a good position, as of a straight but stiff knee, the Surgeon may usually succeed if the ankylosis be only fibrous, (when some degree of movement will always be perceptible in the part,) by the employment of passive motion, frictions, and douches, more particularly with warm salt water or the mineral sulphurous springs. In the more obstinate cases, and where the immobility appears to depend, in some degree at least, on fibrous bands stretching across the joint, an attempt might be made to rupture these by forced movements under an anæsthetic.

2. When fibrous ankylosis has taken place in a faulty position—if, for instance, the knee be bent, or the elbow straight—the first thing to be done is to place the limb in such a position that it will be useful. This may most readily be done by putting the patient under the influence of chloroform, and then forcibly flexing or extending the limb as the case may require, when with loud snaps and cracks it will usually come into proper position. Should any of the tendons or bands of fascia near the joint appear to be particularly

tense, they may be divided subcutaneously some days before the extension is attempted, or else, if it have been carried as far as the rigid state of the tendons will permit, tenotomy may then be practised, and, an interval of a few days having been allowed to elapse, extension may be completed. The muscular contraction will, however, in many cases, yield to gradual extension by means of screw-splints or weights, and thus render tenotomy unnecessary. Sayre states that when the contracted tendon is stretched to the utmost, if a reflex contraction of the muscle can be felt by the finger pressed upon it, it is better to divide it. If no reflex contraction ensue, stretching alone is sufficient. The inflammation that follows this forcible extension or flexion of the limb, is usually but very trivial; an evaporating lotion and rest will speedily subdue it. Indeed, it is surprising what an amount of violence may be inflicted on an ankylosed joint without any bad consequences ensuing. After the limb has been restored to its proper position, passive motion and frictions may tend to increase its mobility.

3. When osseous ankylosis has taken place, and the position of the limb is a good one, it will generally be wiser for the Surgeon not to interfere; except in the case of the elbow-joint, which, in these circumstances, may be excised with advantage, so as to substitute a movable for an immovable articulation. If the position be faulty, the osseous union may be sawn, drilled, or chiselled, and broken through subcutaneously; or a wedge-shaped piece of the bones may be taken out, and the position of the limb thus rectified.

4. Amputation may be required in cases of faulty ankylosis with so much atrophy of the limb as to render it useless, or in cases in which there is necrosed or carious bone co-existing with ankylosis and rigid atrophy of the muscles of the limb.

LOOSE CARTILAGES IN JOINTS.

It sometimes happens that the synovial membrane of a joint assumes a **Warty Condition**, as the result of chronic disease of the articulation, especially in rheumatoid arthritis. This warty state of the membrane arises from hypertrophy of the fringes, chiefly in the neighbourhood of the margin of the cartilages. These may become pedunculated, and pendent into its interior. For this condition, which gives rise to occasional uneasiness and puffiness about the joint, with a crackling or creaking sensation when it is moved, but little can be done beyond the application of a flannel bandage or an elastic knee-cap.

Loose Bodies may be of three kinds. 1. The so-called *melon-seed bodies*. These are usually numerous, sometimes fifty or more in number, white or brownish in colour, and closely resemble the seeds of a melon in form. They are composed most commonly of dense fibroid tissue, and are believed to be due, in many cases at least, to the pedunculated, warty, or villous growths just described as being formed from hypertrophy of the synovial fringes, becoming separated from their attachments by the movements of the joint. In other cases it is possible they may be formed from altered clot, as blood-crystals have been recognized in them. Lastly, König first pointed out that in many cases they are formed from a fibrinous exudation from the synovial membrane due to very chronic tubercular disease. In some cases he demonstrated the presence of tubercle in the synovial membrane. (See Tubercular Dropsy, p. 329.) Melon-seed bodies are more common in the sheaths of tendons and in synovial bursæ than in joints, and in these situations also it has been shown by Nicaise, Poullet, and Vaillard, that they are due to chronic tuberculosis of the membrane.

2. *Fragments of true cartilage.* These may be developed in two ways: first, from the formation of cartilage in the hypertrophied fringes of a warty synovial membrane. In the normal condition a cartilage-cell is present in many of the secondary papillæ of the fringes, and it is easy to understand how this can form the starting point of a cartilaginous growth. In other cases, Billroth believes that they are ossifying cartilaginous growths formed in the fibrous layer of the synovial membrane in rheumatoid arthritis (p. 353), which have subsequently become loose by the wearing away of the superficial layers of the membrane. This mode of origin is somewhat doubtful. These cartilages are usually flattened, with a lobulated irregular border, and frequently contain true bone in their central parts; sometimes they may be partly calcified, but contain no true osseous tissue. They may attain a size of more than one inch in their greatest diameter. They are usually single, but occasionally four or five may be found in the same joint. There is strong reason to believe that these cartilaginous bodies may increase in size after becoming loose in the joint.

3. Numerous cases have been recorded in which the loose body was undoubtedly a piece of one of the articular cartilages broken off by mechanical violence. These present the ordinary appearance of articular cartilage, and may usually be recognized by their having one smooth surface, while the opposite side has small gritty fragments of bone attached to it, which have been torn from the cancellous tissue beneath. They are always single.

Loose cartilages of all kinds are most commonly met with in the knee, but not uncommonly occur in the elbow or the joint of the lower jaw, and occasionally in the shoulder.

Symptoms.—The severity of the symptoms will to a great extent depend upon the mobility of the loose cartilage, and its consequent greater or less liability to be nipped between the opposite articular surfaces in the movements of the joint. When these bodies are tolerably firmly attached to the synovial membrane, they may merely cause weakness of the joint, with occasional synovial effusion. When loose they usually give rise to a very distinct train of symptoms. The most marked of these is the very severe pain which occurs in particular movements of the limb. This comes on suddenly, and is often so intense as to cause faintness or sickness. It is usually followed by a degree of synovial inflammation, and by relaxation of the ligaments. These attacks of sudden pain come on at varying intervals, as the result of movements of the joint: they commonly happen in the knee whilst the patient is walking. It is difficult to say to what this severe pain is due. Richet thinks it may be owing to the synovial membrane being pinched between the foreign body and one of the articular surfaces. I think that it is most probably due to the foreign body being drawn in between the opposite surfaces of the joint, when these are separated anteriorly in the act of flexion of the knee, and then, when the limb is extended, acting as a wedge between these, tending to keep them separate and interfering with the complete straightening of the limb. In consequence of this wedge-like action of the loose cartilage the ligaments are violently stretched, and the sickening pain consequent on this is experienced, followed as happens in a violent sprain, by rapid synovial effusion. The sensibility of the ligaments of a joint is of that peculiar nature that it is called into action only when an attempt is made to stretch them, and thus forcibly to counteract or destroy their natural use. Ligaments may be cut without any suffering, but they cannot be stretched, either by accident or disease, without the most severe pain. In some cases the loose cartilage can be felt under the capsule, by carrying the finger over the joint, slipping back when pressure is exercised upon it, and often possessing great mobility, gliding from one side of the joint to the other, so as to be extremely difficult to fix.

Diagnosis.—The only condition likely to be confounded with a loose body is the displacement of one of the interarticular fibro-cartilages of the knee. The distinction can usually be made by observing that immediately after the sudden attack of pain the knee can be completely extended when it is due to the presence of a loose body, as this rarely if ever becomes jammed between the articular surfaces; while a displaced fibro-cartilage usually remains out of position until replaced by manipulation or movement of the joint, and until this is effected complete extension is impossible.

Treatment.—The palliative treatment consists in supporting the joint with an elastic bandage or knee-cap, so as to limit its movements, and thus prevent the liability to recurrence of the attacks of pain; and in this way the fixation and ultimate absorption of the cartilage may sometimes be obtained. This I have several times seen to occur in patients who either refused to be operated on, or in whom an operation was not thought advisable. Any inflammation that has been excited requires to be subdued by proper antiphlogistic treatment. In all operations for the removal of loose cartilages antiseptic precautions of the most rigorous character should be adopted. By their aid joints may be opened and explored, and foreign bodies extracted with a freedom and safety otherwise unattainable.

If the cartilage occasion frequent suffering, so as to interfere seriously with the utility of the limb, and if it appear to be of large size, and to be loose and single, means may be taken for its extraction. But it must be borne in mind that any operation for its removal by which the joint is opened, becomes a source of danger to limb and even to life unless efficient means are adopted for the prevention of septic arthritis. Although by the proper use of antiseptics this danger may be averted with almost absolute certainty, it is wiser not to undertake the operation without warning the patient of the possible consequences that may follow. No operation should be undertaken so long as the joint is in an irritated state, as the result of a recent attack of pain and inflammation; this must be first subdued, and then the operation may be proceeded with; nor should it be done if the patient's health be broken.

The extraction of the foreign body has been performed in two ways; by direct incision into the joint, and by subcutaneous section. In the operation by direct incision the patient must in the first instance make those movements by which he usually gets the cartilage fixed in the joint. As soon as the Surgeon feels it (as this operation is commonly required in the knee), he pushes it to one side of the patella, where he fixes it firmly with his forefinger and thumb, and an anæsthetic may then be administered. The incision is then made to the capsule of the joint over the loose body. All bleeding should then be arrested, after which the incision may be carried through the capsule and synovial membrane and the loose body may be squeezed out or extracted by means of a sharp hook. Unless the wound be exceptionally large it is wiser not to close it by sutures ; an antiseptic dressing may be applied and the limb rigidly fixed on a proper splint. In cases in which the body is very large, or in which much manipulation of the joint has been necessary so that some synovial effusion may be expected, it may be advisable to insert a drainage-tube for a few days, but, as a rule, this is not necessary. The carbolic spray will be found to give increased safety in performing this operation. Should it not be used, the wound may be irrigated, and great care taken to prevent the entrance of air into the articular cavity. Before the introduction of antiseptic surgery the foreign body was sometimes removed by a valvular wound made by drawing the skin on one side after the first incision before opening the capsule. Anything like a valved opening should be carefully avoided when antiseptics are used, as it interferes with drainage. Formerly the operation was not uncommonly followed by septic arthritis, ending in ankylosis of the joint, or the death of the patient, and sometimes necessitating amputation of the limb. In the present day it is rarely followed by synovial inflammation even of the slightest kind.

It was proposed by Chassaignac, in order to obviate the dangers of a direct opening into the joint, to remove the loose cartilage by subcutaneous section. In operating by this method on the knee, the cartilage should be fixed below and to one side of the patella, between it and the head of the tibia ; a long narrow tenotome is then introduced obliquely under the skin from a distance of about two inches below the loose cartilage ; the capsule of the joint is freely divided, and a space made in the subcutaneous areolar tissue by a slight sweep of the blade : the loose cartilage is then pressed into the cavity thus made to receive it, and slid along the areolar tissue for about two inches. It is fixed *in situ* with a firm pad and adhesive plaster ; the foot and leg are bandaged up to the edge of the cartilage, and the limb is placed on a splint. If no inflammatory symptoms ensue, the cartilage is excised about a week after the operation ; or it may be left to be absorbed. By the adoption of the subcutaneous method there will be but very little danger of inducing undue inflammation in the joint, the entrance of air being prevented ; it is this, and not the mere section of the capsule and synovial membrane, which constitutes the chief risk. Should there be more than one loose cartilage, the operation must be repeated, but not until any inflammation induced by the former one has been subdued. In this way I have successfully removed in succession five loose cartilages from one knee.

CYSTS IN CONNECTION WITH JOINTS.

Morrant Baker has lately called attention to the occurrence of cysts in the neighbourhood of diseased joints, appearing superficially at such a distance from the articulation that their connection with it may not at first be apparent. These cysts are of various kinds. It has already been pointed out that in hydrarthrosis pouch-like projections may protrude from the synovial membrane owing to the pressure of the fluid effused into the joint. This may occur in tubercular dropsy (p. 329), or in Charcot's disease. The fluid thus escaping from the joint may, while still contained in a thin membranous sac, extend to a considerable distance from it. Thus, from the knee it may reach to the middle of the calf, or from the shoulder along the long tendon of the biceps to the middle of the arm. The communication with the joint may be so small that pressure will not force the fluid into the articular cavity. A chronic abscess from a diseased joint may follow the same course, and become superficial at a point far removed from its point of origin. In other cases cysts may be formed by distension of bursæ or synovial sheaths in the immediate neighbourhood of a diseased joint either communicating or not with its cavity. Thus the bursa under the inner head of the gastrocnemius in disease of the knee or that under the deltoid in the shoulder, or under the psoas and iliacus in the hip may become distended with fluid. The so-called "compound ganglion of the wrist" is often associated with chronic tubercular disease of the radio-carpal articulation. In this form melon-seed bodies are often present.

The incautious puncture of these cysts without efficient antiseptic precautions, under the impresssion that they had no connection with the neighbouring joint, has in several recorded cases been followed by septic arthritis and destruction of the articulation. Mere puncture or aspiration cannot from the nature of the case be productive of much benefit. These cysts may, however, be safely incised and drained if proper antiseptic precautions are taken. In some cases in spite of treatment by incision or otherwise the tubercular nature of the affection becomes manifest after a time by progressive disease in the articulation. In two cases of compound ganglion of the wrist in University College Hospital, incision and drainage apparently cured the patients, but some months afterwards tubercular disease developed in the radio-carpal and carpal articulations necessitating excision of the wrist in both cases.

NEURALGIA OF JOINTS.

Pain of a severe character is often experienced in or around a joint, closely simulating, but not dependent upon, inflammation or other structural disease. This pain, which is purely neuralgic, may have its origin either in some local irritation of a nerve leading to the sensitive part, or in constitutional disorder of a hysterical character. It is this class of cases, occurring in young women who are either the subjects of hysteria, or are of a highly nervous temperament, that should especially be considered as **Neuralgia of the Joints,** to which the attention of the profession was directed principally by the labours of Sir B. Brodie.

Symptoms.—It is generally found that the hip, knee, ankle, or shoulder is the joint affected—the hip and the knee more especially. The neuralgia is usually localized in a particular joint by some slight injury that the part has sustained. But it is important to observe that in these cases the pain often does not develop for some days, or even weeks, after the injury that is the alleged cause of it. Severe pain in the joint is complained of; and the limb is rendered comparatively useless, often with a good deal of distortion or contraction. On examination, it will be found that the pain, which is commonly very severe, is superficial and cutaneous, not existing in the interior of the articulation, nor increased by pressure of the articular surfaces against one another; and that it is not strictly confined to the joint, but radiates for some distance around it. This pain is often intermittent in its character, and is frequently associated with neuralgia elsewhere, as in the spine; and not unfrequently with uterine irritation or disease. The patient sometimes acquires the trick of producing loud snappings of some muscle or tendon which are distinctly audible all over the room whenever she walks or moves. At the same time, it will be observed that all the signs that ought to accompany a severe attack of inflammation in a joint, such as would be attended by a corresponding amount of pain, are absent; there being no painful startings of the limb at night, no heat, redness, or swelling nor elevation of temperature; and the suffering being increased by causes, such as mental and emotional disturbance, that do not influence organic disease. Attention to these various circumstances will usually enable the Surgeon to diagnose the nature of the attack without much difficulty; the only cases in which he will really experience any, being those in which the tissues around the joint have been thickened, indurated, and altered in their characters by the application of counter-irritants; or by some slight articular disease having at some time existed, but having been cured.

Causes.—The neuralgia is often referable to the irritation of some particular nerve, either at its origin or in its course. This is particularly the case with neuralgia of the hip and knee, which will often be found to be dependent on irritation of the obturator nerve, owing to intrapelvic disease. In one case of secondary abdominal cancer under my care, the patient was seized with the most intense pain in the right hip and knee, so as to lead to the suspicion that these joints were diseased. On examination after death, it was found that the pain resulted from the implication of the obturator nerve in a mass of intrapelvic cancer, the joints themselves being perfectly sound.

Treatment.—The treatment must be constitutional, directed especially to re-establish a healthy condition of the uterine organs. If there be amenorrhœa and anæmia, aloëtics and the preparations of iron must be given; if ovarian or uterine irritation or congestion exist, this must be removed by proper local means, and the general health attended to. Nervine antispasmodics and tonics, such as valerian and bark, or assafœtida and quinine in full doses should be freely administered. The most efficient treatment that can be directed to the affected joint is the application of cold douches and the employment of the continuous electric current, which will cure cases in which all other means have failed; the application of atropine and aconite may be of service in allaying the pain when especially severe. If contraction or other distortion of the limb exist, the patient should be put under an anæsthetic, and extension or rectification of the faulty position then made, care being taken to keep the limb on splints in a proper position for some time after the operation. Indeed, in neurotic or hysterical joint affections, it is often of much use to do something positive or objective in the way of treatment, so as to give the patient an excuse to get well. It is thus that free manipulation or slight "wrenching" of the joint under anæsthetics is often beneficial. In other cases the good effects following this treatment may be explained by the stretching and restoration of the normal position of muscles which had been allowed to become contracted and displaced by long continued fixity or faulty position of the joint.

CHAPTER XLIX.

EXCISION OF JOINTS.

History.—The operation of resection of the articular ends of bones dates from the very earliest periods of Surgery of which we have any record. Hippocrates (in his Chapter on Injuries of Joints) speaks of resections of bones at the joints, whether of the foot, the hand, the leg, the ankle, the forearm, the wrist, as being for the most part unattended by danger, except from syncope or consecutive fever. Celsus, in speaking of compound dislocations, says, if the bare bone project it will always be an obstacle to reduction; that which protrudes should therefore be cut off. Paulus Ægineta says that, if a bone project, as after a transverse fracture, we must cut it off. Thus, it will clearly be seen that it was the practice of the ancients in compound dislocations, and in compound fractures, to resect the protruding bones. But that the practice of resection in cases of disease also was not unknown to them, is evident from a passage on fistulæ in the works of Paulus Ægineta, who directs that, if the fistula terminate at a bone, and if that be not diseased, it should only be scraped; but if it be carious, the whole diseased portion should be cut out with chisels, and, if necessary, it may have a hole bored in it with a trephine; and a little further on he says, "the extremity of a bone near a joint, if diseased, is to be sawn of; and often, if the whole of a.bone, such as the ulna, radius, tibia, or the like, be diseased, it is to be taken out entire." He makes exceptions in the case of the bones of the spine and pelvis, and the head of the femur, which, he says, should not be operated on for fear of the neighbouring arteries.

The practice of resection, however, fell into disuse, and seems to have been completely forgotten until the middle of the last century, when occasional notices of its adoption appear in Surgical essays. It was first employed in cases of compound fractures and dislocations of joints. In military practice, the Surgeon, in two or three instances, picked out and cut away fragments of the bones forming the wrist-, elbow-, shoulder-, and ankle-joints when shattered by gunshot. This early revival of resection involved no principle of treatment; imperfect operations being had recourse to on the field of battle simply as a matter of convenience in particular cases.

The first resection practised for injury in which the articular ends in compound dislocation were deliberately and successfully removed, appears to have occurred to Cooper of Bungay, before or at latest about the middle of the last century. The precise date of this case is unknown; but Gooch writing in 1758, says that it occurred "many years ago;" that the ends of both tibia and fibula were sawn off in a compound luxation of the ankle; that the limb was preserved, and was so useful that the patient was able to walk and gain his livelihood.

In or about the year 1758, Wainman of Shripton sawed off the lower end of the humerus in a case of compound dislocation of the elbow-joint with perfect success, the patient recovering with an arm as movable "as if nothing had ever been amiss;" and his example was shortly afterwards followed by Tyne of Gloucester, who in a similar case removed two and a half inches of the lower end of the humerus. From this period, the operation of excision of the articular ends of bones in cases of compound dislocations and fractures into joints became an established practice, and was extensively adopted by Percy in France, who, in 1794, exhibited to Sabatier nine soldiers in whom he had successfully excised the head of the humerus for gunshot injury; by Bilguer in Germany, by Hey of Leeds, and by numerous other Surgeons in this country and abroad.

In 1768, White of Manchester removed from a boy of fourteen what he believed to be the head of the humerus, with several inches of the shaft, and the patient recovered with an arm slightly shortened, but perfect in all its movements. The history of the case, however, and the drawings accompanying it, show beyond a doubt that the joint was not implicated, the case being one of acute necrosis, with separation of the upper epiphysis. White, however, strongly advocated excision for disease of joints, and satisfied himself by experiments on the dead body that it was practicable in the hip as well as in the shoulder. Although the head of the humerus was not removed by White, it certainly was three years later by J. Bent of Newcastle, who in 1771 excised by a formal and pre-arranged operation the carious head of the humerus with complete success. His example was followed in 1778 by Orred of Chester, who also operated successfully in a similar case. About the same time, 1775, Justamond, Surgeon to the Westminster Hospital, removed, in a case of disease of the elbow-joint, the olecranon and two inches of the ulna.

In 1762, Filkin of Northwich removed the articular ends of the femur and tibia, together with the patella, in a man affected with disease of the knee-joint, resulting from a fall from a horse. Filkin was led to this operation, in consequence of having experimentally practised it on the dead subject, as a substitute for amputation of the limb, to which the patient refused to submit. The patient recovered rapidly, had a useful limb on which he was able to walk long distances, and was certainly alive nearly thirty years after the operation. This remarkable case seems to have attracted little, if any, attention, and indeed was not published until 1790, after Park of Liverpool brought before the Profession his second successful case of excision of the knee-joint, which occurred in 1789. That Surgeon had performed his first operation of this kind most successfully, as regarded utility of limb, in 1781, apparently without any knowledge of the operation that had been done by Filkin.

The example thus set by the English Surgeons was speedily followed by the Moreaus in France, who, between the years 1786 and 1789, sent various memoirs to the French Academy on this subject. The operation, however, was violently opposed by the great body of Surgeons, and, with the exception of the occasional removal of the head of the humerus, fell into almost complete neglect both in this country and abroad for a period of nearly forty years, during which time the records of Surgery do not contain as many cases in which the articular ends of bones were excised for disease. It continued in this languid state until 1831, when it received a new and vigorous impulse, so far as its application to diseases of the elbow was concerned, by the publication of Syme's essay on that subject, and by the practice of Liston some years subsequently at University College Hospital.

In 1845 these operations were again prominently brought before the Profession by the performance of excision of the head of the femur by Fergusson; and although excision of the knee-joint had occasionally been practised by Syme, Crampton, Textor, Demme, Heyfelder, and others, it was not until its revival in 1850 by the same accomplished Surgeon, that it came to be extensively practised. Since that period, the operation of excision has been applied to almost every joint within reach of the Surgeon's knife.

Before proceeding to discuss the different resections in detail, we must endeavour to lay down some general rules for their performance in those cases in which alone they are admissible.

Indications for Excision.—The excision of an articulation may be practised for the following reasons :—

1. As a substitute for amputation in cases in which *the joint is so extensively diseased*, that the patient will be worn out by the discharge or pain, unless it be removed. Here a useful limb may be secured by the sacrifice of the diseased part.

2. In some cases of articular disease in which *amputation would not be justifiable*, excision may be done in order to hasten the cure, and thus to save years of suffering to the patient.

3. Excision may be done in cases in which *amputation is not practicable;* as in some cases of disease of the hip-joint or of the temporo-maxillary articulation.

4. As a substitute for other and less efficient treatment, in order *to restore the utility of a limb or joint;* as in osseous ankylosis of the elbow, or in faulty ankylosis of the knee.

5. Excision may be required in *bad compound dislocations and fractures into joints*, especially in *gunshot* injuries; more particularly in those of the head of the humerus, and of the bones entering into the elbow-joint.

As a general rule excisions are required only in those cases in which the articular ends of the bones are diseased either primarily or secondarily. If only the soft structures of a joint be involved, it usually happens that, without the necessity of resection or operation of any kind, a useful limb will result—in the upper extremity, with fair mobility of the articulation ; in the lower, with more or less complete ankylosis, sufficient for a fair basis of support. But when the constitution is very strumous, or the bones are primarily or extensively affected, we can scarcely expect that the limb will recover to such an extent as to become useful.

In determining the necessity of excision the circumstances of the patient must be taken into consideration. Among the upper classes who can enjoy all the advantages of good food, change of air and careful nursing, it is rarely necessary to excise a joint, and the operation should never be undertaken till prolonged efforts have been made to obtain a cure by other means. In hospital practice, on the other hand, we have to deal with patients whose circumstances make it almost impossible for them to receive the prolonged attention essential to the recovery of a chronically diseased joint, and in them excision may often with advantage be performed at an earlier period.

Conditions of Success.—For resection to succeed, the following conditions appear to me to be necessary :—

1. *The disease should not be too extensive,* so that its removal would entail such an amount of mutilation of the limb, as to render it less useful to the

patient than an artificial member would be. This is especially important in the lower extremity. If the bones be so extensively affected as to require to be shortened by several inches, a limb would be left which would be only a useless incumbrance. In the upper extremity, length and strength are of less consequence than in the lower ; the preservation of the hand is the chief thing to aim at, and, if this be effected, the bones may be encroached on to a greater extent than is proper in the lower limb.

2. The disease for which resection is practised should be *allowed to become chronic* before any operation is undertaken : for this there are two reasons. First, in the acute stage of disorganization of a joint, it is not always possible to say, however unpromising the case may appear, whether ankylosis may not result, so that as useful a limb would be left as could be obtained by resection. And, secondly, if the joint be excised whilst acute and active disease is going on, inflammation and diffuse suppuration of the medullary canal are liable to set in—a condition very apt to be followed by pyæmia. In the only fatal instances of resection of the elbow-joint that I have witnessed, death resulted from this cause ; the operation having been performed whilst the articular affection was acute.

3. *The soft parts about the joint must be in a sufficiently healthy state.* There are two morbid conditions connected with the soft parts that may interfere with the success of resection. First, they may be so thinned and permeated by sinuses, and so adherent to the bones, that an insufficient covering would be left. Or, secondly, the long-continued existence of strumous disease in joints and bones may give rise to great infiltration of the tissues around the articulation with chronic inflammatory products often in a state of fatty degeneration or containing tubercular centres either caseating or softening. The tissues in this state are incapable of healthy repair. Chronic abscesses form, leaving sinuses when they discharge their contents, and the integuments become blue and doughy ; and the soft parts around the seat of operation fall into a state of disorganization, that prevents alike the formation of a false joint, osseous ankylosis, or the healing of the wound, and thus leads inevitably to the ultimate amputation of the limb. Even though this exudation-matter do not exist in large quantity, if the joint be peculiarly loose, owing to softening and disorganization of ligamentous and tendinous structures, excision is not very likely to succeed, especially in the ankle or knee.

4. *The state of the patient's constitution* must necessarily influence the Surgeon materially in his determination whether to resect or to amputate. If the constitution be tolerably sound, or even if the general health have given way as the simple consequence of pain, and continued discharge, resection will have a fair prospect of success. In fact, when the patient is hectic in consequence of continued suppuration, the removal of the joint or bone that maintains it may be advantageously practised. But if the patient is suffering from septic fever in consequence of the absorption of the discharges from ill-drained cavities opening on the surface by narrow sinuses, the operation is likely to be followed by osteo-myelitis and pyæmia, and is not a safe proceeding until the constitutional disturbance has been relieved by making free incisions, and providing good drainage. These incisions should be so placed as not to interfere with subsequent excision. Again, if the constitution appear to be very much broken down, the patient being anæmic, wasted

or cachectic, especially if there be an evening elevation of temperature with no suppuration in the joint to account for it, excision of the larger joints, as the knee and hip, is not desirable, as it is very probable that the patient is suffering from general tuberculosis. If the patient be very highly strumous, or decidedly phthisical, there will be little prospect of his being able to bear up through the long convalescence that often follows resection. The earlier stages of pulmonary phthisis, if unaccompanied by distinct elevation of temperature, need not be a bar to the operation. In such cases I have several times had occasion to observe that the general health improved rapidly after removal of the local disease. Extensive albuminoid degeneration of the liver and other viscera is always a serious obstacle to excision, although amputation may sometimes be safely practised.

5. *The extremes of life are unfavourable* to resections. In very early childhood, these operations are seldom necessary; the natural processes usually sufficing, with very little assistance, to eliminate diseased bone, and the disorganized joints admitting readily enough of ankylosis. If the disease be too severe for this, it will usually be found to be associated with so strumous a constitution as to interfere with healthy reparative action of any kind. Another serious objection to these operations in young children is that, should the epiphyses be removed, the development of the limb will be to a great extent arrested. At advanced periods of life, destructive joint-disease is not very common, and when it does happen, it is generally in constitutions not fitted to bear up against the prolonged drain consequent on these operations. It is at the early adult age, when the diseases most frequently occur that render resections necessary, that these operations are best borne.

Repair after Excision.—The mode of repair after resection of bones or joints differs according to the circumstances of the operation.

When, as very commonly happens in cases of necrosis, the periosteum, thickened, infiltrated, and loosened, can readily be detached, or, indeed, is already separated, without injury to itself, from the dead bone, reproduction of new osseous tissue to a very considerable extent may be expected. My own observations on the fibula, tibia, and ulna, and those of Ollier and Maisonneuve, prove the importance of the periosteum as an organ of repair after the extraction of a dead shaft or bone from within it. Repair in this way is, I believe, chiefly to be looked for in the shafts of the long bones; although some Surgeons, as Annandale of Edinburgh, have described the os calcis as having been reproduced after subperiosteal excision. The remarkable osteogenetic properties possessed by the periosteum have been conclusively established by the experiments of Ollier. He has shown that a bone is much more rapidly and perfectly reproduced after removal, if the periosteum be left, than if it be removed, and he states that the osteogenetic properties of this membrane are greater in the long than in the short bones. He is of opinion also that resections of joints performed by the subperiosteal method give better results, so far as the shape and formation of the new articulation are concerned, than if this membrane be sacrificed. These observations, indeed, conclusively establish the importance of making in all cases every effort to preserve the periosteum during a resection.

When a short bone, as the os calcis, has been entirely removed, with its periosteum attached, it is never regenerated, but its place is occupied by a thick, firm, fibrous cicatrix.

In some cases in which a considerable portion of the diaphysis of a long bone is taken away, repair may be imperfectly accomplished owing to sloughing of the periosteum. In a case of this kind in which two-thirds of the shaft of the humerus were lost, Macewen succeeded in obtaining complete restoration by transplantation of small fragments of bone obtained from the wedge-shaped pieces cut out of different patients for the cure of rickety curves in the tibia. The fragments measured about two-fifths of an inch in length and thickness, and the operation was performed with antiseptic precautions. This ingenious mode of treatment certainly deserves a further trial.

When a joint has been excised, either osseous or ligamentous ankylosis may take place or a false joint may be formed, and the Surgeon should endeavour to secure the form of union most suitable to the case. Thus, when the knee has been excised, as a sound and firm limb is desirable, osseous ankylosis should, if possible, be brought about; whilst in the upper extremity mobility is of more importance than strength, and we consequently aim at obtaining firm fibrous ankylosis, allowing of some mobility at the wrist and a false joint at the elbow. In fibrous ankylosis, the opposed bony surfaces are united to each other by dense fibrous tissue. In a false joint the ends of the bones become rounded and covered by a layer of fibroid tissue almost resembling cartilage in density and smoothness, and are united by a capsule of fibrous tissue resembling normal ligaments in structure. The inner surface of this capsule is smooth and imperfectly covered by flattened cells, and thus somewhat resembles a synovial membrane, but the cavity is moistened with serous fluid such as is found in false bursæ and not true synovia. The muscles that are naturally connected with the articular ends that have been removed form new attachments to the bones either directly or by means of the fibrous capsule of the false joint.

The question as to the arrest of the development of the bone, and consequently of the whole limb on which an operation of excision has been performed, is one of great practical moment. It is well known to physiologists that the longitudinal growth of a bone is carried on chiefly through the medium of the layer of cartilage by which the epiphysis is attached to the shaft, and which does not become ossified until the bone has attained its full length. It has further been pointed out by Humphry, that the two epiphyses of the long bones of the limbs do not take an equal share in this development, that which unites last taking the greater part. Thus the upper epiphysis in the humerus and tibia, the lower epiphysis in the radius and femur, are the more important in this respect. If, therefore, in an excision practised on a growing child, the whole of the epiphysis be removed, the subsequent growth of the bone will be arrested proportionately to the share that the epiphysis which is removed takes in the development of the bone. And if that epiphysis on which the length of the bone is chiefly dependent, be removed,—as, for instance, the upper epiphysis of the tibia and humerus, or the lower epiphysis of the thigh-bone—the development of the limb will be very considerably interfered with. In the adult, after ossification is completed, the epiphysis loses its importance as an organ of growth; and may be removed, if necessary, without interfering with the subsequent length of the limb, except to the extent of its removal.

Instruments.—The instruments required for resection are of a somewhat varied character: strong scalpels and bistouries, straight and sharp-pointed.

In addition to these I have found a strong-backed, probe-pointed bistoury with a limited cutting edge, of great utility in clearing the bones. Periosteal elevators of various forms are necessary if the operation is to be performed subperiosteally. The pliers should be of various sizes and shapes (Figs. 513 to 516), and gouges or sharp spoons will be found useful for scooping out suspicious patches on the cut osseous surfaces. For ordinary purposes, a small broad amputating saw will be found the most convenient instrument for dividing the bones; but in some cases a narrow keyhole saw, or that introduced by Butcher (Fig. 542), will answer best. The last-named instrument is especially useful when it is intended to cut the bone obliquely, or when the space is limited; for, as the blade is narrow and its angle can be changed at pleasure, any required direction can be communicated to the cut. I almost invariably use it in preference to all others in resections. But some Surgeons prefer, especially in resection of the knee-joint, a short and very broad-bladed saw, the blade being of breadth greater than the whole thickness of the bone to be divided. The chain-saw is perhaps not used so frequently as it might be.

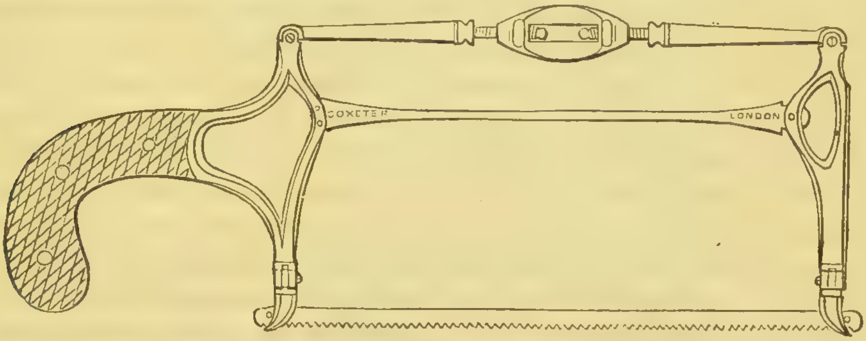


Fig. 542.—Butcher's Saw.

Operation.—The steps of the operation must of course vary with the different resections; but there are some general rules that may be laid down as applicable to all cases.

1. The incisions through the soft parts should be sufficiently free to expose thoroughly the bones to be removed. By making them, as far as practicable, parallel to tendons, blood-vessels, and nerves, parts of importance may readily be avoided.

2. As little of the bone as possible should be removed. The gouge or sharp spoon may be applied to any carious cavities or patches that appear upon the surface of the freshly-cut bone; and, in this way, shortening of the bone by the saw may be materially avoided.

3. In young children the epiphyses should, if possible, not be entirely removed, as it is on the growth of this portion of bone, or rather on that of the epiphyseal cartilaginous layer adjoining the shaft, that increase in length of the bone is mainly dependent.

4. In adults in whom the bone has attained its full length, the epiphysis may be more freely removed, if necessary. But the shaft should not be encroached upon if it can be possibly avoided, and especial care should be taken not to open the medullary canal.

5. The periosteum should be carefully preserved, being stripped off the bone

where it is thickened and loosened, and manipulated very gently, so that its vitality may be impaired as little as possible.

6. It is of great importance not to confound bone softened by inflammation, but otherwise healthy, or roughened by the growth of osteophytes, with that which is carious or necrosed.

7. Skin, however redundant, should never be cut away. The flaps, at first too large, soon shrink down to a proper size, and, if trimmed, are very apt to become too scanty.

8. In cases of ordinary white swelling, the pulpy granulation-tissue occupying the site of the synovial membrane should be removed as thoroughly as possible, partly by scraping with a sharp spoon and partly by forceps and scissors.

9. After the operation, if the skin were previously unbroken, the wound may be treated by any of the antiseptic methods already described in the chapter on Wounds, the edges being brought together as accurately as possible and proper provision made for drainage by the insertion of tubes. If sinuses exist and the discharges are not aseptic at the time of the operation, an attempt should be made thoroughly to disinfect the wound. For this purpose the sinuses should be scraped with a sharp spoon and afterwards scrubbed with a small piece of sponge held in a pair of forceps and soaked in a solution of chloride of zinc (gr. xl. to ℥j.), perchloride of mercury (1 in 500), or tincture of iodine (ʒij. to Oij.). The whole wound should also be washed with some powerful antiseptic solution, and afterwards treated by some antiseptic method. Thorough drainage and antiseptic treatment have of late years greatly diminished the death-rate after excisions in general, and especially of the knee. After the dressing is applied, the limb must be placed on a pillow or a well-padded splint according to the joint operated on. As healing progresses, great attention must be paid to position, and passive movement must be commenced after the first week when a movable joint is desired.

10. The constitutional after-treatment should be nourishing or stimulating. As there may be a great drain on the system should profuse suppuration set in, with prolonged confinement to bed, the strength must be kept up under it by good diet. These operations are always serious ; in many cases fully as much so as the amputation of a corresponding part, or even more so, owing to the large wound that is often inflicted in the more extensive division of the bones ; to the necessity of making the incisions in the midst of diseased structures ; and to the more prolonged character of the after-treatment.

11. Should caries or necrosis return after the operation, *secondary resection* may be required. This I have done successfully at the hip, shoulder, and elbow-joints. In the elbow, in one case I performed a third resection with perfect success ; the two previous operations, which had been performed by other Surgeons, having failed.

EXCISIONS IN THE UPPER EXTREMITY.

The whole of the upper extremity is subservient to the hand. By the excision of any one articulation the limb may be shortened, and it may be weakened ; and yet, if sufficient length and strength be left to enable the individual to use his hand, an immense gain will result. Hence, provided the Surgeon can save the hand, he need not hesitate to sacrifice other portions of the limb; and the shoulder, elbow, or wrist, may be removed, and the patient left in the possession of a most useful member; shortened, it is true, and to a certain extent curtailed in its movements, but possessing all the delicate motions of the hand in full perfection.

Shoulder-joint.—Excision of the shoulder-joint may be required for two conditions: 1. Disease, and 2. Compound and Comminuted Fracture of the articulation.

1. **Excision for Disease.**—For disease, excision is not so commonly required in this as in many other articulations; primary disease of the soft structures of this joint not being very frequent, and, when it occurs, usually terminating in fibrous ankylosis, without suppuration. When carious and necrosed bones are met with about the shoulder, it will occasionally be found that the coracoid or acromion processes, or the scapular spine, are at fault rather than the osseous structures of the joint itself. In some cases a small sequestrum lying in a carious cavity in the head of the humerus may be removed by slitting up sinuses, without the necessity of excising the joint.

When excision is required for disease of the shoulder-joint, it is usually for caries commencing in the head of the humerus, especially in children and young adults. In these cases it will usually be found that the glenoid cavity is affected secondarily, and to so limited an extent that it readily recovers when the irritation caused by the friction of the head of the humerus against it is removed.

Excision of the upper end of the humerus has been practised for sarcoma, but this operation is not usually advisable in such cases. Bickersteth has successfully removed the head of the humerus for exostosis. In cases of intra-capsular fracture through the neck of the humerus, with detachment of the head of the bone, disorganization of the joint has resulted. This has been laid open, and the loose head of the bone removed in two instances by Brainard of Chicago; the patients recovering with useful limbs.

Operation.—Partial Excision of the head of the humerus in some cases of caries has been practised by slitting up sinuses and the application of the gouge or sharp spoon to the diseased osseous surface. Occasionally, as in cases reported by Fergusson and Sédillot, these operations have been attended with successful results. But not unfrequently they fail in effecting a cure, the disease extending, and the sinuses not healing, so that eventually excision of the whole of the diseased head of the bone has been required.

Complete Excision of the head of the humerus is the operation usually required. It may be practised in several different ways—the lines of incision through the soft parts being varied according to the conditions of the case. They are most commonly made on the front or outer side of the joint through the deltoid muscle, but in exceptional cases the head of the bone may be removed from behind. Excision may be performed by the single longitudinal, or its modifications the ┐ or T-shaped incision, or by a U-shaped incision or flap-operation.

The operation by the **single longitudinal incision** may be performed as follows. The patient lying on his back, with his shoulder slightly projecting over the edge of the table, the Surgeon enters the knife to the outside and above the coracoid process, about half an inch below the clavicle, and carries it directly downwards for from three to four inches, stopping immediately above the insertion of the pectoralis major. The first incision should divide the skin and fat, and pass through the anterior fibres of the deltoid, so that when the wound is held open the capsule of the shoulder-joint comes into view. This incision is immediately external to the cephalic vein, which should not be wounded, and divides no important artery or nerve. The wound being now held open with blunt hooks or copper spatulæ (Fig. 543), the bicipital groove should be felt for between the great and small tuberosities of the humerus. A longitudinal incision is then made firmly on to the bone along the inner side of the groove, dividing the periosteum covering the head of the bone, and the capsule as far as the margin of the glenoid cavity. If the long tendon of the biceps be still undestroyed by the disease it must be turned out of the groove and held to the outer side in a blunt hook. The assistant then rotates the arm forcibly outwards, so as to bring the small tuberosity well into the wound, and the Surgeon separates the tendon of the subscapularis and the periosteum from the bone with a periosteal elevator. In most cases of disease of the joint this can be done without great difficulty, as the adhesion of the tendon to the bone is loosened by the inflammation. Should the adhesion of the tendon be too firm to allow of its being stripped off with the elevator the knife must be used, but care should be taken to shave the capsule off in such a way as, if possible, to leave it still connected with the periosteum covering the upper part of the humerus. The arm then being rotated inwards, and the limb allowed to fall over the edge of the table, the three muscles inserted into the great tuberosity are separated from the bone in the same way as the subscapularis. During this part of the operation the biceps tendon must be drawn to the inner side with a blunt hook. The assistant then forces the head of the bone up into the wound whilst the Surgeon separates the posterior part of the capsule with an elevator, leaving it attached, if possible, to the periosteum below. He now takes the limb in his own hands, and having the soft parts well retracted, he pushes the head of the bone out of the wound so as to allow the easy application of the saw by which it is removed. Should the parts around the head of the bone be thickened, and unyielding, more space may be gained by making a short cross cut at the upper end of the longitudinal incision, and thus converting it into a modification of the ⅂ or T. By this method of operating, the posterior cir-

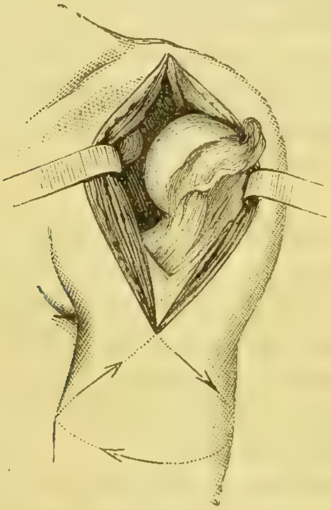


Fig. 543.—Excision of Shoulder-joint. Longitudinal Incision.

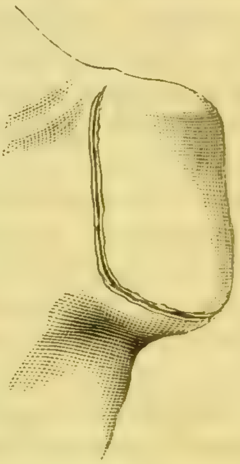


Fig. 544.—Stump after Amputation at Shoulder-joint by Spence's method.

cumflex artery and the circumflex nerve are not divided, and but few vessels will be found to require ligature. The fibres of the deltoid are little interfered with, and if the incision be not carried too low, the insertion of the pectoralis major will be at most only partially cut through. It is recommended by some Surgeons to make a small opening behind through which a drainage-tube can be passed, emerging a little below the acromion. In doing this care must be taken to keep well above the posterior circumflex artery. By this means drainage is certainly facilitated, and the healing of the anterior wound is hastened.

Should the extent of the disease or injury prove to be so great as to require amputation of the limb, this may readily be done, as was suggested by Spence of Edinburgh, by carrying the knife round the inner side of the limb, and so detaching the member, with due attention to those points in connection with the axillary artery that have been described at p. 108, Vol. I. The result, as seen by the annexed drawing (Fig. 544), is very satisfactory.

The **elliptical operation** of excision may be performed in the following way. A curved incision is made, commencing at the posterior part of the acromion, reaching downwards to the insertion of the deltoid, and terminating at the outer side of the coracoid process. By a few touches of the scalpel, a large flap composed of the deltoid muscle may thus be raised, and the diseased articulation fully exposed. As in the operation just described, an attempt should be made to save the capsule and maintain its connection with the periosteum. For this purpose a longitudinal incision should be made through the capsule, and it should be stripped off with the tendons and periosteum by means of the periosteal elevator, aided by the knife when necessary. The head being pushed out may then be removed with a narrow saw. The shaft of the humerus should be encroached upon as little as possible, so that the arm may not be shortened more than is necessary. After the operation, the flap must be retained in position by sutures, and a drainage-tube inserted behind.

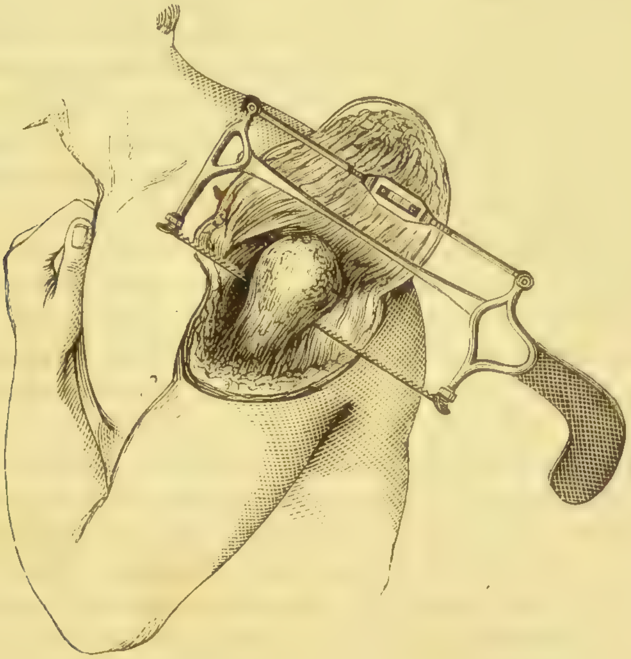


Fig. 545.—Excision of Shoulder-joint. Elliptical Incision.

After the removal of the head of the bone, the glenoid cavity must be examined. If this be merely superficially carious it may be let alone, but should it be more deeply implicated, with cavities hollowed out in it, perhaps containing sequestra, the diseased bone must be thoroughly removed by means of gouge-forceps and the gouge.

When the sinuses open entirely behind it is possible to excise the joint by an incision made through the posterior fibres of the deltoid, commencing immediately below the root of the acromion, and carried downwards for an inch and a half or two inches, but not so low as to endanger the circumflex nerve and artery. The space thus obtained is limited, and does not allow of a methodical subperiosteal excision being performed as above described, but in most cases the capsule is softened by the disease, and the adhesion of the tendons so far loosened that there is no difficulty in forcing the head of the bone out of the wound. This operation was performed with the best results a few years ago by Christopher Heath in University College Hospital.

After excision of the joint, the arm must be well supported in a sling, the elbow especially being raised. A pad should be placed in the axilla to prevent the tendency of the pectoralis major, teres major, and latissimus dorsi to draw the arm inwards. The union, which is by granulation, is usually slow.

Result.—The shoulder-joint in its normal condition possesses five distinct movements: 1. Rotation; 2. Abduction and Elevation; 3. Adduction; 4 and 5, movements in the antero-posterior direction. These movements vary greatly in importance in the course of the ordinary affairs of life. The most useful are those of abduction, and the two in the antero-posterior direction. These are requisite in all ordinary trades and for the guidance of the hand in most of the common occupations of life. The movements of elevation are seldom required, except by those who follow climbing occupations, as sailors, bricklayers, &c. Now the mode of performing the operation, as well as the operation itself, will materially influence these different movements. Thus, if the deltoid be cut completely across by an elliptical incision, and the circumflex nerve divided, the power of abduction of the arm and of its elevation will be permanently lost. If its fibres be merely split by a longitudinal incision (Fig. 543), they may be in great part preserved. The movements of rotation, &c., which are dependent on the actions of the muscles that are inserted into the tuberosities of the humerus, are usually permanently lost; for in all cases of caries of the head of the humerus requiring excision, the Surgeon will find it necessary to saw through the bone below the tuberosities —in its surgical, and not in its anatomical neck. Hence the connection of the supra-spinatus, infra-spinatus, and teres minor, and the subscapularis to the bone will all be separated. Should the Surgeon however succeed in maintaining the connection of the capsule of the joint and the tendons with the periosteum by adopting the subperiosteal method of operating above described, the divided tendons may form new attachments to the humerus, and the muscles retain their functions in a greater or less degree. Those muscles which adduct and which give the antero-posterior movements, viz., the coraco-brachialis, the biceps, the pectoralis major, latissimus dorsi, and teres major, will all be preserved in their integrity; and hence it is that the arm, after this excision, is capable of guiding the hand in so great a variety of useful under-handed movements. In the case of a man whose shoulder-joint I removed many years ago, I last saw the patient about fifteen years after the operation had been performed, and then found that the upper end of the humerus had been drawn up underneath and between the acromion and coracoid processes, where a false joint had formed. The arm was extremely useful, and all the parts below the elbow were well developed. The upper arm was shortened by two and a half inches.

Excision of the shoulder-joint is on the whole a very successful operation, as regards life as well as limb. Hodges has collected 50 cases of excision of the head of the humerus for disease: of these, 8 died and 42 recovered from the operation. Of these 8 deaths, 3 only occurred before the third month, and 3 were from phthisis. In 2 only did death appear to have been directly occasioned by the operation. In but 17 of these 50 cases was the glenoid cavity interfered with; but it is a remarkable circumstance that in no fewer than 7 out of the 8 fatal cases this cavity was diseased, and was treated by gouging, excising, or cauterization.

2. **Excision for Compound and Comminuted Fracture.**—When excision of the shoulder-joint is required for compound and comminuted fracture from gunshot injury, the operation is of a less formal character. The bullet-holes must be laid freely open in a longitudinal direction, or the deltoid even cut across at its superior attachment, all loose splinters removed, and the ragged ends of bone cut off with pliers or a narrow saw; especial care being taken in manipulating towards the inner and under sides of the joint, in the vicinity of the large nerves and vessels. Without going back to the earlier cases of Percy, Larrey, and other military Surgeons of the latter part of the last century, who frequently practised this operation with the happiest results, the more recent experience of the wars in Europe and America demonstrated its great utility, and that it ought invariably to be preferred to amputation at the shoulder-joint in all cases in which the large blood-vessels and nerves are intact. Hodges states that in 96 recorded cases from all sources there were 25 deaths, or a mortality of 26 per cent. But in the Crimean war the result was much more satisfactory. Thus Bauden relates 14 cases occurring in the Crimea, with only 1 death; and in the British army, of 14 cases, 12 recovered; whilst of 60 amputations at the shoulder-joint 19 were fatal. In the American war, the mortality in 575 cases of excision of the shoulder-joint was at the rate of 32·5 per cent. Primary excisions were more successful than secondary: the percentage of mortality in the former (252 in number) being 23·3, and in the secondary (393 in number) 38·6.

Excision of the Scapula, partial or complete, may be required for caries, necrosis, or tumour of that bone. Caries and necrosis do not very commonly affect the scapula primarily. When the bone becomes the seat of these diseases, it will generally be found that the acromion and the spine are the parts affected. In such cases the progress of disease is usually very slow, and it will generally be found that the carious bone may be effectually gouged out, or the sequestrum extracted, by laying open sinuses, and thus exposing the diseased osseous surface by irregular and informal operations. The whole bone has, however, become affected by necrosis, caries, and chronic inflammation to an incurable extent. In two instances the whole bone has been excised for disease of this kind following amputation at the shoulder-joint for caries of the humerus. The operators were Rigaud of Strasburg, and Fergusson. Both cases did well.

The preservation of the arm after removal of the scapula is a matter of very considerable importance. The Surgeon who first ventured on the bold operation of **Removal of the Whole Scapula** was Cumming, in 1808. Gaetani Bey, in 1830, first amputated the arm and then proceeded to extirpate the shoulder-blade. In 1819 Liston removed the whole of the upper two-thirds of the scapula from a lad without sacrificing the arm. In 1828 Luke removed nearly the whole of the scapula from a girl of fourteen for malignant disease, sawing across the bone through its neck and the root of the acromion, and thus leaving the glenoid cavity and the acromion process. Hayman, Janson, Wützer, and Textor have all performed similar operations, removing the greater part of the bone, but leaving the glenoid cavity and more or less of the parts above the spine. In 1837 Mussey (U.S.) excised the whole of the scapula and the clavicle for an enormous osteo-sarcoma ; the patient, a man, was, according to Gross, in excellent health fifteen years after this operation. In 1850 Gross removed the whole of the scapula, with the exception of the glenoid cavity, by sawing through the neck of the bone, for an osteo-sarcoma weighing seven pounds. Indeed, the American Surgeons have distinguished themselves highly in this department of surgery. Thus, in 1838, McClellan removed the whole of the scapula with the clavicle for a soft sarcoma, but the patient died. In two cases Gilbert (U.S.) removed the scapula, half of the clavicle, and the upper extremity, one patient living a week, the other three months, after the operation. In 1845 Mussey successfully operated by the removal of the scapula, the outer half of the clavicle, and the upper extremity. In Gross's case, the only portion of the scapula left attached to the upper extremity was the glenoid cavity. In 1856 Syme went a step further in this direction, and, by disarticulating the bone instead of sawing through its neck, removed the scapula with all its processes entire from a woman seventy years of age, also leaving the arm untouched. Since that period complete removal of the scapula, leaving the arm untouched, has been done several times by Syme, Jones of Jersey, Cock, Fergusson, Pollock, Heath, and others. The arm so left becomes useful, capable of performing all the underhand movements, and of lifting considerable weights ; and it may now be looked upon as an established rule in surgery that it should never be removed unless it also be the seat of disease, rendering necessary that addition to the excision of the scapula. Fergusson preferred sawing through the root of the acromion to disarticulating that process, so as to give greater roundness to the shoulder and to preserve the attachment of the trapezius.

Partial Excision of the Scapula has usually been practised for tumours of that bone. The extent of bone requiring excision will necessarily vary greatly according to the size and character of the tumour, and the severity of the operation will mainly depend upon whether it is the upper or the lower portion of the bone that is the seat of disease. When the tumour is situated towards the lower angle of the bone, it may be exposed by a crucial or T-shaped incision, and the body of the bone sawn through transversely below its neck and spine. In such cases the hæmorrhage need not be very great, as the main trunk of the subscapular artery, or even the dorsal artery of the scapula, is not necessarily divided. If the tumour spring from and be connected with the spine and acromion, only projecting forwards over the shoulder and leaving the rest of the bone sound, and the joint unaffected, it may be freely exposed, the spine of the scapula sawn or cut across with pliers, and the mass turned off from the point of the shoulder, without injury to the articulation or the implication of vessels of any importance.

When the tumour occupies the upper half of the scapula, the case is much more formidable, and the line of practice to be adopted must depend upon the parts involved. If the disease involve the body of the bone, encroaching upon the supra- or infra-spinous fossa, extending forwards into the axilla below the neck of the scapula, and thus coming into relation with the subscapular artery, it would be wiser to remove the whole bone, than to attempt the resection of the upper half, leaving only the lower angle, which would be useless to the patient.

When the body of the scapula is involved in a morbid growth, extending over the greater part or the whole of the subscapular or infraspinous region, and stretching forwards under the latissimus dorsi muscle into the axilla, the case becomes infinitely more serious, as not only must the whole of the scapula be removed, but the subscapular artery must be divided, and the axillary plexus of nerves and vessels brought into the field of operation. In these cases, also, the question as to the preservation or removal of the arm has to be considered. Whenever the joint is sound, and the upper part of the limb free from disease, it should be preserved; and, as these conditions usually exist where the disease originates in the scapula, the contemporaneous or antecedent amputation of the arm is seldom required.

Operation.—Excision of the scapula may be performed by exposing the bone freely by V-shaped, ⊤-shaped or crucial incisions. The method most commonly adopted has been by the T-shaped incision. A long incision is made extending from the acromial end of the clavicle downwards along the axillary border of the scapula to the lower angle; from the middle or upper third of this a second incision is carried at right angles reaching to the posterior border of the bone, near the root of the spine. The flaps thus formed are dissected up and turned back, the trapezius being raised in the upper flap if it is not implicated in the tumour. The acromio-clavicular articulation, the outer end of the clavicle, or the base of the acromion is then cut through according to the extent of the disease. By feeling for the notch in the upper border of the scapula the situation of the suprascapular artery can be ascertained, and unless it is overlapped by the tumour it may be at once tied and divided. The posterior scapular may be now sought for by carefully dividing the levator anguli scapulæ, beneath which the main trunk will be found, and may be secured. An assistant can then force his finger forwards in the upper and outer angle of the wound, and compress the subclavian artery against the first rib. The muscles attached to the posterior border may then be divided, the serratus magnus being cut as close as possible to its insertion, and the hand passed to the ventral aspect of the bone, which is thus drawn forcibly backwards and outwards. The muscles attached to the coracoid process may then be divided or the process sawn through at its root. The whole bone can now be drawn still further outwards, and the joint opened from the inner side by dividing the subscapularis close to its insertion. The disarticulation is then completed, and the remaining muscles divided, the knife being kept as close as possible to the bone so as to avoid wounding the main trunk of the subscapular. The posterior circumflex is in danger of being cut as the long head of the triceps is divided unless the edge of the knife be turned away from it. The teres major should be cut near its attachment to the scapula.

In this operation the hæmorrhage is necessarily copious, and may be dangerous, but by compression of the subclavian artery after the early stages of the operation, and the immediate application of forcipressure-forceps (two dozen of which at least should be at hand) to every bleeding point, it can usually be kept well under control.

After the operation the flaps must be laid down and retained in position by sutures, free drainage being provided by means of tubes.

Result.—In 1878 Von Adelmann published the results of 61 cases of total removal of the scapula which he had collected from medical literature. Of these, 46 recovered, 14 died, and in one the result was not ascertained. These cases include those in which the arm was removed at the same time as the scapula and several in which the amputation or excision of the head of the humerus had been performed at some previous time. In 17 cases in which the subsequent utility of the arm was mentioned, it was very good in 12; in one only was it recorded as being very slight. In fact the danger is much less than might at first be supposed from an operation of such magnitude.

CLAVICLE.—The clavicle may require to be partially or wholly excised. In caries or necrosis of this bone, portions of it may be gouged away or extracted without much difficulty, the bone being rarely affected through its whole thickness, and its posterior part not requiring removal; but when, in consequence of the growth of tumours, the removal of the whole or greater part of the bone is necessary, the operation is one of the most hazardous in surgery, as a glance at the anatomy of the parts lying beneath the bone, and encroached upon by the morbid growth, will indicate. In 1828 Mott excised the clavicle for an "osteo-sarcoma" which measured four inches in diameter. This operation was one of great difficulty; it occupied four hours in its performance, and forty ligatures were required to restrain the hæmorrhage. The subclavian vein, thoracic duct, and phrenic nerve were exposed, but the patient made a good recovery, and was alive many years afterwards. Similar operations, but not perhaps of quite so formidable a character, have been performed by Warren, Travers, Curtis of Chicago, Cooper of San Francisco, and other Surgeons. It is obviously impossible to lay down definite rules for the performance of an operation in which the circumstances must vary so greatly in each case as in this, and for the safe conduct of which the Surgeon must be indebted mainly to his anatomical knowledge. It may be stated generally that the bone requires to be exposed by a free incision along its whole length: it is then sawn across or disarticulated at its acromial articulation, and carefully dissected out in a direction from without inwards, the sternal end being forcibly twisted out, and its ligamentous connections cautiously divided, care being taken to avoid the important vessels and nerves in the lower part of the posterior triangle of the neck, and to prevent, by ligature before division, the entry of air into any vein which it may be necessary to divide. The sternal end of the clavicle has been excised by Davie of Bungay in a case in which dislocation backwards had resulted from deformity of the spine, and the luxated end, gradually pressing upon the œsophagus, threatened the life of the patient. The bone was cut through by means of a Hey's saw about an inch from its sternal end, and, the sterno-clavicular ligaments having been divided, the portion of bone was forcibly elevated, and extracted.

ELBOW-JOINT.—In tracing the history of the introduction of excision of the elbow-joint into surgical practice, we find, as is the case in several other parts, that it was first partially and then wholly done for injury, and proposed by one Surgeon and eventually practised by another for disease. Thus in 1758 or 1759, Wainman, in a case of compound dislocation of the joint, sawed off the lower end of the humerus just above the fossa, leaving the patient with a flexible and useful arm. Tyne, of Gloucester, did the same, removing two and a half inches of the lower end of the humerus, in a case of compound dislocation. Justamond, of the Westminster Hospital, was the first to operate in a case of disease: this he did in 1775, removing the olecranon and two inches of the ulna. Park proposed, but did not have an opportunity of practising, the complete excision of the joint. This was done for the first time by Moreau, senior, in 1794, and again by Moreau, junior, in 1797. Little was done from this time until the operation was revived by the Surgeons of Leeds; in 1818 by Stansfield, in 1819 by Chorley and Hey. It then made rapid progress, and was specially practised by Syme and Liston, and the Surgeons of the Edinburgh Infirmary.

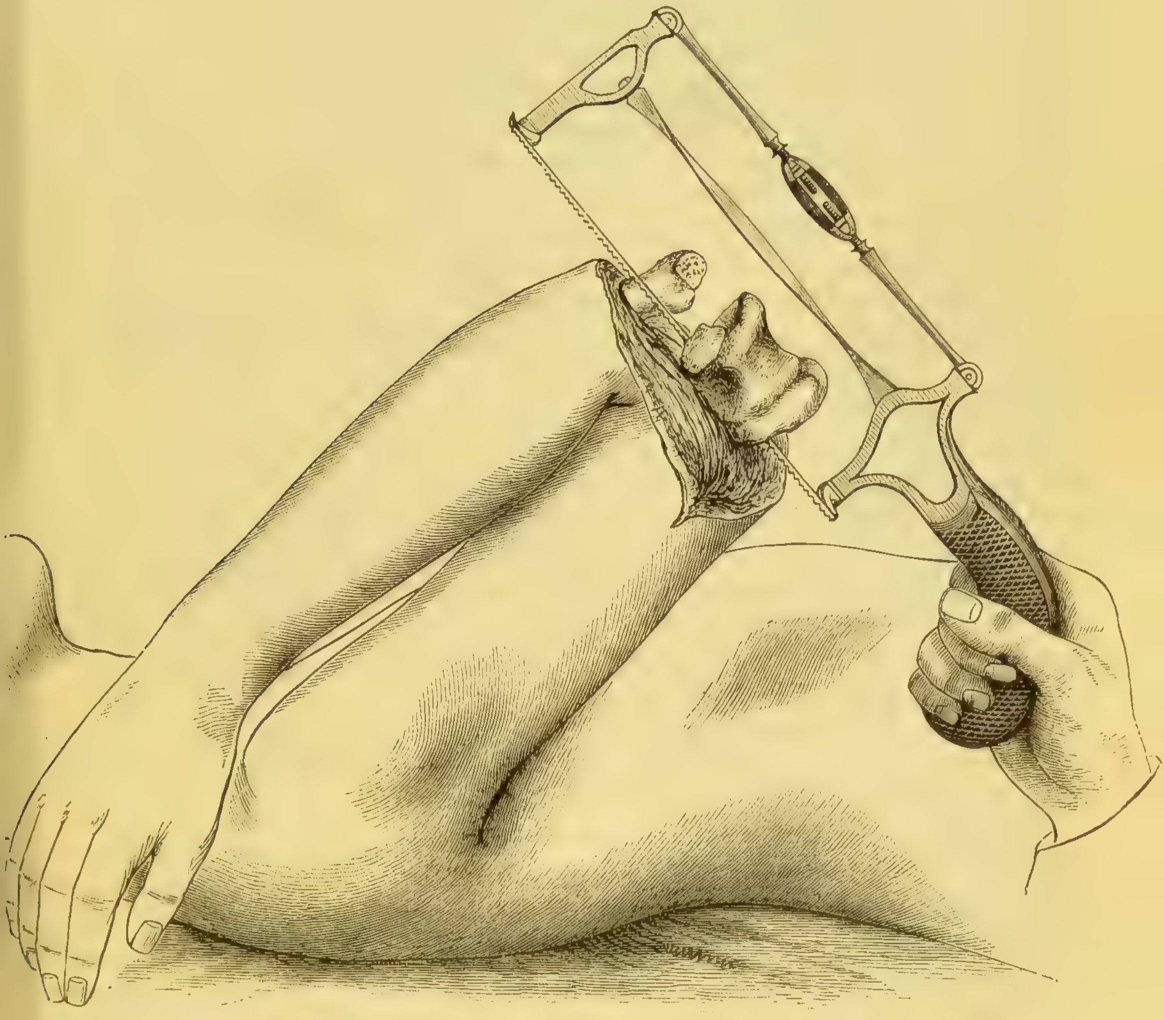


Fig. 546.—Excision of elbow-joint. Sawing the humerus.

This operation may be required, 1, for Chronic Disease of the Joint; 2, for Osseous Ankylosis; and 3, for Compound Fractures and Dislocations.

1. *Strumous Arthritis* or *white swelling* (p. 345), is the disease for which

excision of the elbow-joint is most commonly required in young subjects. It may commence either in the synovial membrane or in the bones. In this disease, the limb becomes useless, the joint is extremely painful on movement, and the surrounding soft parts are swollen, spongy, and perforated by sinuses from the openings of which fungating granulation-tissue usually projects. In older subjects the mischief will usually be found to be seated principally in the bones, and the swelling of the surrounding parts is often not great. There may be merely one or two sinuses leading down to carious or necrosed bone in the condyles or the olecranon, the joint being permanently flexed and the arm useless. On opening the joint loose pieces of dead bone may be found lying in the hollow of the olecranon, or in one of the condyles of the humerus, the rest of the articular surfaces being carious with more or less complete destruction of the articular cartilages. Most commonly, the radius is the last bone that is affected, the ulna and the articular end of the humerus being generally first diseased. In some cases excision is required on account of acute destructive arthritis secondary to suppuration taking place outside the joint and extending into it. The elbow forms an exception to the rule that excision of a joint is not to be undertaken while there is a hope of obtaining a cure by ankylosis. Provided the patient is otherwise healthy, the operation may be performed as soon as it is evident that the movements of the joint will be lost should recovery take place under simple treatment.

2. If *osseous ankylosis* have occurred, whether in the straight or in the bent position, excision may advantageously be practised, provided the patient is in good health. This operation was first performed in 1827, by Rhea Barton of Philadelphia. When the elbow is ankylosed in the straight position, the arm is quite useless ; and any operation by which flexion of the limb can be obtained, will add materially to the patient's comfort, rendering the hand available for most purposes of life. In cases of *angular* osseous ankylosis of the elbow, a wedge-shaped piece of bone should be removed.

3. In cases of *compound fracture or dislocation* of the elbow-joint, more or less complete resection of the protruding, and possibly splintered fragments, may be required (pp. 598 and 685, Vol. I.).

Operation.—Excision of the elbow-joint may be performed by the H, the T-shaped, or the simple longitudinal incision, or by two longitudinal incisions. Each method has its advocates. The H-shaped operation consists in making an incision parallel to, and a little to the radial side of, the ulnar nerve, another along the outer side of the joint, and uniting the two by a cross cut, dissecting up and down two square flaps, and clearing the bones laterally. It was soon found by Surgeons that by this method a very unnecessary amount of incision was practised ; and accordingly the vertical cut along the outer side was dispensed with, and the ⊢-shaped operation adopted. This consists in making the longitudinal incision parallel to, and a little to the radial side of the ulnar nerve, and the cross cut over the olecranon to the outer side of the joint. Subsequent experience has shown that this incision may be still further simplified, and the operation reduced to a single longitudinal incision carried over the centre of the joint in the middle line from above downwards. In comparing these different methods of operating, I decidedly give the preference to the single longitudinal incision, as being quite sufficient in all ordinary cases for the complete and easy removal of the articulation. Both the H- and T-shaped incisions involve, moreover, a complete transverse division of the tendon of the triceps, in consequence of which the power of active extension of the limb may be lost after recovery from the operation. Should the soft structures towards the outer side of the joint not yield sufficiently, a cross-cut can at once be made, so as to liberate them, and give the Surgeon more room, by turning up the two triangular flaps that will thus be formed.

The following are the successive steps of the operation by the T-shaped and single longitudinal incisions. Should the former be adopted, either in consequence of the situation of the sinuses or of previous incisions for the relief of abscesses, the arm being held across the chest, the perpendicular cut should be made parallel to, and a line or two to the outer side of, the ulnar nerve; being commenced at least two inches above the point of the olecranon, and carried down to about three inches below it. The transverse incision may then be made directly across the end of the olecranon, to the outer side of the joint, and extended as far as the extremity of the outer condyle (Fig. 547). The two triangular flaps thus made must be dissected up, the knife being carried close to the bones (Fig. 548). The subsequent steps are the same in the operation by the single longitudinal incision.

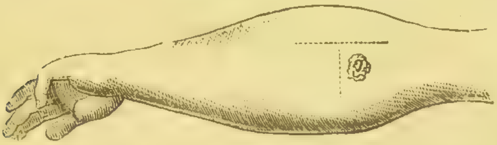


Fig. 547.—Excision of Elbow-joint; ⊢-shaped Incision.

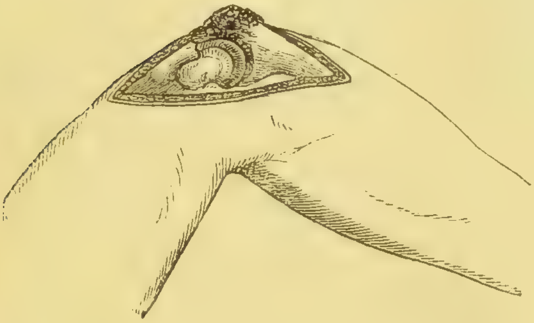


Fig. 549.—Excision of Elbow-joint by Longitudinal Incision.

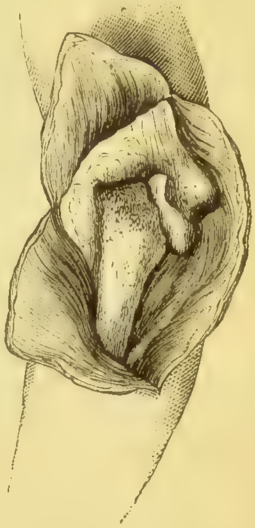


Fig. 548.—Excision of Elbow by ⊢-shaped Incision. Bones exposed. Ulnar Nerve indistinctly seen.

In the operation by the *single longitudinal incision* the arm is held in the position just described, and the incision is commenced from two to three inches below the tip of the olecranon and carried directly over the middle of that process, terminating a similar distance above it. If the parts are much swollen, the length of the incision must be increased so as to allow of the sides being held well apart. The incision must be carried firmly down to the bones so as completely to divide the tendon of the triceps in a longitudinal direction. The arm is then slightly extended, and soft parts cleared from the inner side of the joint. To do this the thumb must be pushed into the longitudinal slit in the triceps, and the tendon thus put on the stretch and shaved away from its attachment. If the periosteum is swollen and loosened by inflammation, this may be wholly or in part done with a periosteal elevator, and the connection between the tendon and the periosteum be preserved; more commonly, however, the knife has to be used. After the triceps is separated, the remaining soft parts must be carefully turned off the inner side till the internal condyle comes into view. In doing this the edge of the knife should always be kept against the bones, or the periosteal elevator may be used, so that the ulnar nerve may be turned over the inner condyle without injury. If the incision be properly made and the knife kept in contact with the bone, the nerve ought not to be exposed during the operation, more particularly as it is usually embedded in the inflamed tissues surrounding it. When the inner side of the joint has been sufficiently cleaned the soft parts must be turned back in the same way on the outer side. In doing this it is very important to save uninjured the strong tendinous expansion that passes from the triceps over the surface of the anconeus, to be attached to the posterior border of the ulna. If this be preserved, the connection between the triceps and ulna is maintained, and the patient will regain the power of active extension of the joint when recovery has taken place. When the posterior part of the joint has thus been laid bare, the tip of the olecranon should be removed by cutting pliers, so as to give free access to the articulation. The limb is then flexed forcibly till the forearm touches the arm, the humerus being held vertically at right angles to the table ; the fore-arm is at the same time pulled towards the table. The lateral ligaments being then divided by a touch of the knife, the articular surface of the humerus projects from the wound, and can be removed by a narrow saw cutting from the anterior surface. If the sawn inner condyle form too sharp a point, a small piece may be removed with the bone-forceps. The bones of the forearm are then forced out of the wound by the assistant and cleaned with the elevator or knife till the cartilage-covered surfaces are sufficiently exposed to be removed by the saw. The brachial artery is so completely protected by the brachialis anticus that it could not easily be wounded, but if there is much pulpy swelling of the synovial membrane it will sometimes be found useful to press a copper spatula between the humerus and the bones of the forearm to facilitate the exposure of their ends for sawing. The ulnar nerve is in danger while the inner side of the ulna is being cleaned for the saw, and sometimes during the sawing of the bone, and it must therefore be guarded or drawn on one side by a bent copper spatula or a blunt hook. Should any sinuses exist, especially towards the inner side of the arm, they had better be left untouched. I have more than once known the ulnar nerve cut across by the Surgeon in laying open what appeared to be very superficial sinuses in this situation.

In this operation it is of great consequence, so far as the after-utility of the arm is concerned, not to remove more of the bones lengthwise than is absolutely necessary. The shaft of the humerus, for instance, should never be encroached upon ; it will be quite sufficient to limit the excision to the articular surface. Should any carious portions of bone extend beyond this, I think it is better to scoop them out with the gouge than to remove them in any other way. The excision of the ulna and radius should not be carried so low as to divide the insertions of the brachialis anticus and biceps. After opening the articulation, a practical question of considerable importance often arises ; viz., to what extent the resection of the articular ends should be carried. If they be all diseased, there can of course be no doubt as to the propriety of removing the ends of the three bones. So, also, if the humerus and ulna be diseased, the head of the radius should be cut off on a level with the section of the ulna. But the important point is, whether, in the event of only one bone being implicated, by disease or injury, the Surgeon should limit himself to the excision of this alone, or should remove the other two. Formerly, in accordance with the principle of conservative surgery, that diseased or injured parts alone should be sacrificed, I have advocated leaving the healthy articular ends, and only removing that which was diseased; but increasing experience has convinced me that the practice is erroneous, and that, if the joint be only partially excised, ankylosis, or return of the disease in the bones, is very apt to ensue. I would therefore advise that in all cases, the whole of the articulation be removed, as well as in those cases in which operation is required in consequence of comminuted and compound fracture of only one of the bones; as, for instance, when the lower epiphysis of the humerus, or the upper end of the ulna only, is the seat of such injury. In excision of the elbow for osseous ankylosis, a piece of the united bones about an inch in length should be sawn out; the cuts should be made at right angles to the shafts of the bones, and the piece removed must include equal portions of humerus and of ulna.

The operation by *two lateral incisions* has lately been recommended by Hueter and others. The advantages claimed for this method of operating are that it saves to some extent the injury to the triceps involved in the other methods, that it provides better drainage, and that the scars are left at the lateral aspects of the new joint instead of behind. The inner incision should be the shorter, and should be made first, the ulnar nerve being turned out of its groove and the internal lateral ligament of the joint divided. The outer incision should be of considerable length, and should pass close to the radial border of the olecranon. Hueter recommends that the external lateral ligament should be divided and the head of the radius removed first. The lower end of the humerus can then be dislocated and forced out at the external wound, or sufficiently exposed to be safely sawn with a narrow-bladed saw; after which the olecranon and the upper end of the ulna can be cleaned with the elevator, protruded from the wound, and removed.

In all methods of operating it is generally recommended to save as much of the periosteum as possible. Ollier states that the results obtained by subperiosteal resection are far better than those by the older methods. In practice it will be found that, in excision for disease, whether the knife or the periosteal elevator be used, if the rule of keeping the instrument close to the bone be followed, the greater part of the periosteum will be saved, as its adhesion is always loosened by the inflammation. In primary excisions for injury, on the other hand, the greatest care must be taken to save the periosteum, otherwise a flail-like joint is very apt to result.

In many cases of excision of the elbow no vessels require ligature, though there may be free general oozing. I have never seen troublesome bleeding. After the operation the wound may be closed with sutures and treated according to the rules already laid down (p. 376).

Much of the success in the result of the excision of this, as of other joints, will depend upon the care and attention bestowed on the after-treatment of the case. The object of the treatment is to obtain a strong false joint possessing all the natural movements of the elbow. In order to do this a somewhat different course of treatment must be adopted in different cases. In all excisions for disease, we have to guard against ankylosis; undue mobility is very rare, and I have never seen it. In primary excisions for injury, a flail-like joint is not uncommon, especially if much bone has been removed and the periosteum not preserved. I have met with it in one case—that of a young woman, the lower end of whose humerus was completely disorganized by a fall, and the elbow-joint opened. In this case the lower epiphysis of the humerus was excised, together with the articular ends of the ulna and radius. A good recovery took place ; but, although every care was taken to support the limb on splints, a very movable joint was left. In excisions for disease, or for the secondary results of wounds, we may in most cases dispense with splints. After the operation, the limb may be laid upon a pillow nearly in the extended position. Some of the Edinburgh Surgeons have recommended that the limb should be placed in the fully extended position with a very gentle weight extension applied to the wrist to prevent the bones from coming in actual contact with each other. This treatment has been tried in University College Hospital, and found to be very comfortable to the patient. At the end of a week or ten days passive movement must be commenced. In doing this, care must be taken not to grind the bony surfaces against each other; gentle extension must be maintained while the angle of the limb is altered. At first it is sufficient merely to alter the position of the limb, letting it lie in the flexed position one day and the extended the next. As the wound heals more extensive movements may be carried out daily. Pronation and supination must not be neglected, and in carrying out these movements the ulna must be held steady with one hand while the radius is rotated on it by the other hand. The pain accompanying passive movement is much less if it be commenced early than if it be delayed till fibrous union has taken place between the bones. Splints are required only if there should be any tendency to displacement immediately after operation, if more than the usual amount of bone has been removed, or if there should be any tendency to excessive looseness of the new joint after the third week. The patient can usually leave his bed at the end of the second week, and the arm must then be carried in a sling.

In primary excisions for injury, a properly-constructed splint is frequently required for some weeks, as the tendency is usually towards a flail-like, fibrous union rather than to ankylosis. A splint jointed opposite the elbow will be found useful in many cases so as to allow of variation of position when necessary. Pronation and supination must not be neglected, and must be made when the splint is removed, as no apparatus has yet been invented which will allow of these movements being carried out in a normal way whilst it is applied.

By the above mode of treatment a useful false joint can almost always be obtained. In two cases which I have had the opportunity of dissecting, one sixteen months and the other two years and a half after the operation, it was found that the ends of the bones were rounded and firmly held together by a capsule of dense ligamentous tissue. In this way a most excellent and useful limb will result, having the four movements of flexion, extension, pronation, and supination nearly perfect, with but little deformity, as may be seen by the accompanying cut (Fig. 550), which was taken nearly two years after operation from a patient of mine. A coachman, whose elbow-joint I excised, was able to drive, to lift a pail of water, and to do all the duties of his employment, nearly as well as if the arm had retained its normal condition.

Should there be any danger of ankylosis, the patient may be put under chloroform and forcible flexion and extension be employed; after which, passive motion must be kept up daily. If this fail, care must be taken that the ankylosis occurs in a flexed position.

Should recurrence of disease take place, resection may be again resorted to with success. In one case, indeed, which had been unsuccessfully operated on twice by other Surgeons, I excised the bones about the elbow for the third time with complete success, removing a considerable portion, nearly three inches, of the necrosed shaft of the humerus, and the carious upper ends of the radius and ulna. In this case, which was that of a boy about fourteen years of age, complete recovery took place. He had a most useful arm, regaining the four movements of the joint, pronation, supination, flexion, and extension, and this notwithstanding his being of a most strumous habit. Six months after the excision he was obliged to have one thigh amputated for disease of the bone, and he eventually died at the end of two and a half years, of caries of the spine.

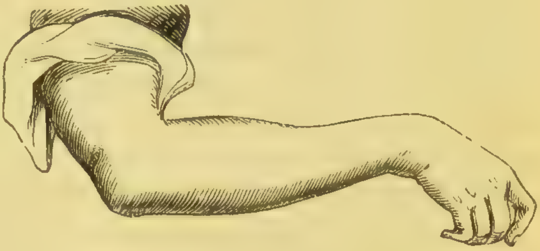


Fig. 550.—Arm after Excision of Elbow.

Results.—Excision of the elbow-joint, so far as life is concerned, is a very successful operation. The result, when it is practised for compound fracture or dislocation, has already been stated at pp. 598, 685, Vol. I. When practised for disease it is equally satisfactory; and indeed death can occur only from some unforeseen and accidental complication, such as may, and does occasionally, follow any operation. I have lost only one patient out of very many in whom I have excised the elbow-joint. The principal danger after this operation arises from diffuse suppuration of the medullary canal of the humerus. I have seen this happen in two fatal cases in the practice of others, pyæmia developing in both instances; and in a third, in which the patient lost his life, it is probable that death, which was attributed to pneumonia, occurred from the same cause.

Ulna or Radius.—One or other of the bones of the forearm has occasionally been excised with advantage, leaving a sufficiently useful limb with good power in the hand. Carnochan of New York and Jones of Jersey have successfully excised the whole ulna. In a case recorded, by Weist (U.S.), nearly the whole ulna was removed on account of gunshot wound. Care was taken to preserve as much as possible of the periosteum; and reproduction of the bone, forming a very useful limb, had taken place at the end of a year. Butts of Virginia has removed the whole radius. In a woman who was under my care about twenty years ago, I also successfully resected the whole radius, with the exception of its articular head, which was sound (Fig. 552); and a useful arm, of which the annexed figure is a good representation, was left (Fig. 551). After a time the hand gradually inclines towards the radial side of the arm; but, although the articulation between it and the forearm is but a slender one through the medium of the ulna, a very useful member will be left. These operations do not require any specific rules for their performance; the bone is exposed by a long incision in the direction of, and made by slitting up, the sinuses that burrow amongst the muscles, and is then carefully dissected out from the parts amongst which it lies; especial care being taken to preserve the periosteum and any new bony deposits that may already have been formed. In one case in which the elbow-joint was involved, and the radius diseased, instead of amputating the limb I obtained an excellent result by excision of the articulation as well as of the affected bone. The patient, a builder about thirty years of age, was able, four years after the operation, to use his hand not only for all the ordinary purposes of life, but also in his trade.

The **Olecranon** has been successfully removed in some instances; for disease by Birkett of Guy's Hospital; and on account of non-union after fracture by Newman of Stamford. In each case a useful arm was retained.

WRIST.—Excision of the wrist formerly found less favour with Surgeons than the removal of other joints. The objections raised to it were, first, that in caries of the carpus the disease very often extends rapidly, with great constitutional disturbance, to all the small bones that enter into its formation, and consequently partial operations rarely succeeded in curing the disease; and, secondly, that owing to the superficial character of the articulation, and its close connection with the flexor and extensor tendons, methodical operations by the older methods were almost invariably followed by a stiff and useless hand. The experience of the last twenty years has, however, shown that complete excision of the carpus with the lower ends of the bones of the forearm, and the bases of the metacarpal bones, may in suitable cases be undertaken with a good prospect of preserving a useful hand. I had a case in 1858, in the person of a middle-aged man in whom the whole carpus and a portion of the bases of the metacarpal bones were removed, and who recovered with a very useful hand, with some power of flexing and extending the wrist, and with very considerable mobility of the fingers. To Sir Joseph Lister, and to West of Birmingham, however, is due the merit of proving the practicability of the operation. The mode of operating planned by the former of these Surgeons will be described here. But before giving the details of this operation, it may be well to mention the principles on which it is founded. On looking at the movements of the wrist-joint, it will be seen that they are somewhat limited in extent, so that if tolerably firm fibrous ankylosis can be obtained between the lower ends of the radius and ulna and the upper ends of the metacarpal bones, the normal amount of movement is maintained. Should these movements be lost or should the union be so loose as to necessitate the application of a rigid apparatus to support the wrist, the hand may still be perfectly useful,

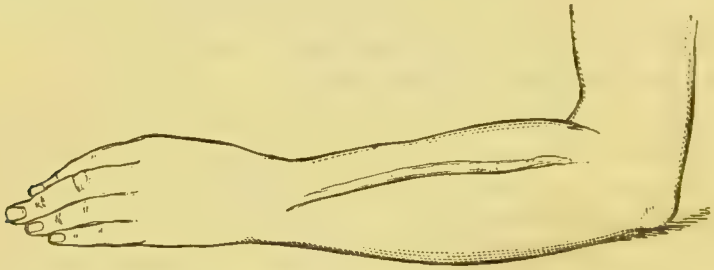


Fig. 551.—Arm from which Radius has been removed.

Fig. 552.—The Radius after Removal.

the lost movement at the wrist being supplemented by those of flexion and extension at the elbow. But the hand cannot be useful if the flexion and extension of the fingers be seriously interfered with. The essential principle of Lister's operation is to save uninjured all the tendons concerned in the movements of the thumb and fingers. If we look at the tendons that surround the wrist, we shall find them divisible into five groups: 1. Those special to the thumb; 2. The extensors of the fingers; 3. The flexors of the fingers; 4 and 5. The extensors and the flexors of the wrist. Now the incisions are so planned as to save the whole of the first three groups, and to divide only the tendons of the wrist proper, and these are cut so close to their insertions that as a rule they form new attachments and resume their functions as recovery takes place.

Lister's Operation.—From the result of two cases of severe injury to the wrist-joint, which recovered with useful hands, Lister was led to the conclusion that, with proper after-treatment, the tendons about the wrist might be very freely handled without permanent stiffness resulting. At the same time, he hoped by removing the whole of the cartilaginous surfaces to be able to prevent recurrence of the disease—which is the common ending of cases of partial excision of the wrist-joint for caries of the carpus. At the time when he published his papers, he had performed the operation of excision of the wrist fifteen times. The method of operating was essentially the same in all; various small details being altered as experience suggested. The operation, as he now performs it, is done as follows. Before commencing, Esmarch's bandage and tourniquet should be applied, as without them the oozing of blood interferes considerably with the operation. Any adhesions of the tendons then existing must be forcibly broken down by moving the

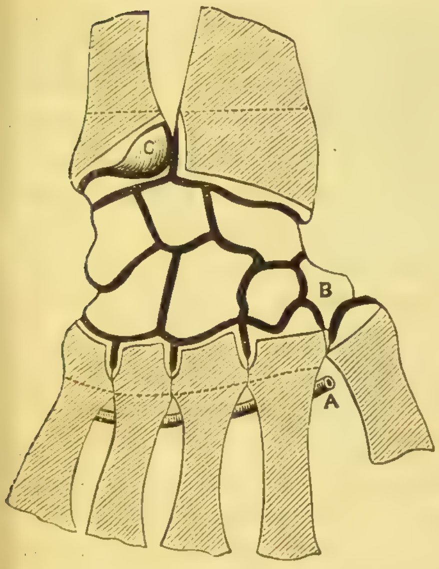


Fig. 553.—Diagram of Wrist. A. Deep Palmar Arch. B. Trapezium. C. Articular Surface of Ulna over which Radius moves. (Lister.)

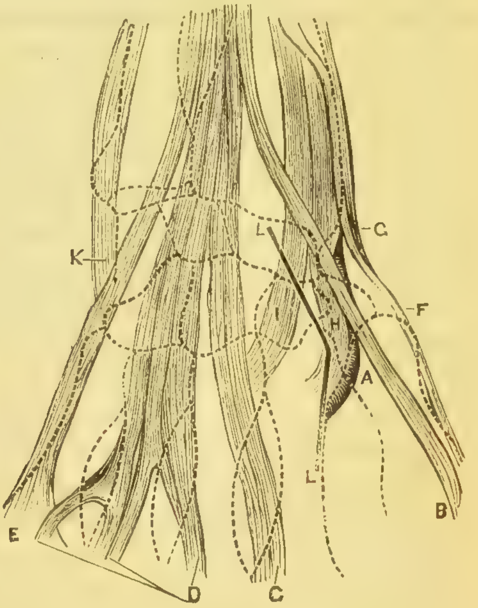


Fig. 554.—A. Radial Artery. B. Tendon of Extensor Secundi Internodii Pollicis. C. Extensor Indicis. D. Extensor Communis Digitorum. E. Extensor Minimi Digiti. F. Extensor Primi Internodii Pollicis. G. Extensor Ossis Metacarpi Pollicis. H. Extensor Carpi Radialis Longior. I. Extensor Carpi Radialis Brevior. K. Extensor Carpi Ulnaris. L. L. Line of Radial Incision. (Lister.)

joints. An incision is now made "from about the middle of the dorsal aspect of the radius, on a level with the styloid process, downwards and outwards towards the inner side of the metacarpo-phalangeal articulation of the thumb; but, on reaching the line of the radial border of the metacarpal bone of the index finger, it is carried downwards longitudinally for half the length of that bone." This incision should commence in the angle formed by the tendons of the common extensor of the fingers and the extensor secundi internodii pollicis, and the upper part should run parallel to the latter tendon, but without injuring it. The tendon of the extensor carpi radialis brevior will be cut, but that of the longior will escape for the present, and the angle formed by the two parts of the incision should be close to the inner side of its insertion. If the first part of the incision be carried too far, there is danger of wounding the radial artery. The soft parts are then to be separated carefully from the bones on the radial side of the incision, the tendon of the extensor carpi radialis longior being now cut as close to its insertion as possible. The tendon of the extensor secundi internodii pollicis and the radial artery are to be pushed outwards out of the way. The trapezium must then be separated from the rest of the carpus by cutting in the longitudinal part of the incision with the bone-forceps. The soft parts on the ulnar side of the radial incision are now to be dissected up as far as can be conveniently done, the remainder being raised from the ulnar incision. While this is being done, the tendons must be relaxed by extending the joint. The trapezium is not to be removed yet, as any attempt to dissect it out before removing the rest of the carpus would endanger the radial artery and the tendon of the flexor carpi radialis. The ulnar incision is now to be made. It must be a free incision, commencing at least two inches above the end of the ulna and immediately to the palmar aspect of the bone, and being carried directly downwards between the flexor carpi ulnaris and the ulna, and then straight on as far as the middle of the palmar aspect of the fifth metacarpal bone. The tendons and soft parts on the dorsum of the carpus are now to be completely raised. In doing this the tendons must be relaxed, and they are to be raised as little as possible from the radius or metacarpus. The extensor carpi ulnaris is to be cut as near its insertion as possible, and the dorsal and internal lateral ligaments may now be divided. Then the soft parts are to be raised from the palmar aspect. The knife must be carried close to the ulna, so as not to wound the artery and nerve. The pisiform bone is to be separated and left attached to the tendon of the flexor carpi ulnaris, which is not to be cut. The flexor tendons are to be raised from the metacarpal bones, but in doing this the hook of the unciform bone must be clipped off with the bone-forceps, and care must be taken not to cut below the bases of the metacarpal bones, for fear of wounding the deep palmar arch. The tendons must be relaxed during this part of the operation by flexing the wrist. The bone-forceps may now be introduced, first between the carpus and radius, and then between the carpus and metacarpus; by this means the whole of the carpal bones (except the trapezium and the pisiform bone) are separated from their connections, and may be extracted in one mass with a large pair of sequestrum-forceps, any bands which retain them being touched with a knife.

The ends of the radius and ulna may now be easily protruded from the ulnar wound. If on examination they be found only slightly diseased, the ulna may be sawn obliquely so as to remove only its articular surface and to leave almost the whole of the styloid process. A thin slice may be taken off the end of the radius, so as to remove only the cartilaginous surface ; and its articular surface for the ulna may be cut away longitudinally with the bone-forceps or a chisel. By leaving the ulna as long as possible and by saving the styloid process, the tendency to displacement of the hand to the ulnar side is somewhat counteracted. If the bones be extensively diseased, the gouge and bone-pliers must be used freely. The next step is to expose the bases of the metacarpal bones, and to treat them in the same way as the radius and ulna, saving as much bone as possible, but removing all cartilaginous surfaces with a narrow-bladed saw. The second and third are most easily protruded from the radial, and the fourth and fifth from the ulnar, wound. The trapezium may then be dissected out, being held in a strong pair of forceps. In doing this care must be taken, first, not to wound the radial artery, which is in close relation with its outer side ; and, secondly, not to cut the tendon of the flexor carpi radialis, which lies in its groove. When the trapezium is removed, the base of the metacarpal bone of the thumb may be pushed up and cut off with the bone-pliers or a small saw. It is better to remove it, as it may suffer from recurrence of the disease, and by its removal the thumb is reduced in length to the same extent as the fingers. Lastly, the pisiform bone may be examined, and either removed entirely, or its cartilaginous surface cut off, as the case requires. During the operation, the only tendons necessarily divided are the extensors of the wrist. The flexor carpi radialis may escape, from its attachment being situated low on the bases of the second and third metacarpal bones, and the flexor ulnaris is left attached to the pisiform bone. All the extensors of the thumb should be uninjured. All the tendons necessarily divided must be cut as long as possible, so that they may form new attachments in the most advantageous positions ; and, in raising the flexor and extensor tendons, they must be disturbed as little as possible.

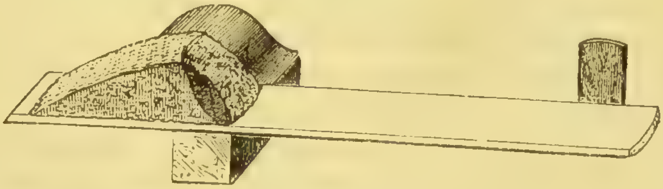


Fig. 555.—Lister's Splint with Cork Support for Hand.

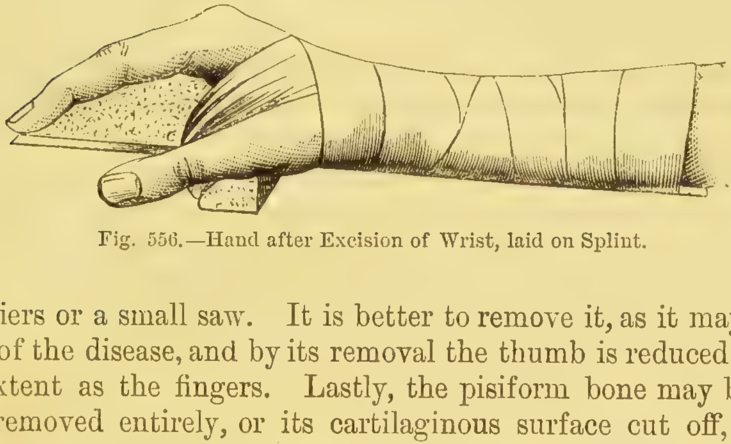


Fig. 556.—Hand after Excision of Wrist, laid on Splint.

After-treatment.—The radial wound may be closely united with sutures. The ulnar wound may be closed at each end, but the middle of the wound is to be kept open by means of an india-rubber drainage-tube to allow free exit of discharge. The hand is to be placed on a splint. The most convenient is a simple wooden splint, "with an obtuse-angled piece of thick cork" stuck on it so as to maintain the hand in a state of semi-flexion, with the wrist slightly extended (Fig. 555). The thumb is supported by a bar of cork stuck on the under surface so as to project at the side (Fig. 556). The two great objects in after-treatment are to get the fingers perfectly movable and the wrist firm. For these purposes passive motion must be commenced as early as the second day in the fingers, each being bent and extended every day fully, while the wrist is kept firmly on the splint and disturbed as little as possible during the treatment of the fingers. Special care must be taken to flex the metacarpo-phalangeal articulations, which are very apt to remain stiff. Pronation and supination must not be too long neglected. Passive motion must be maintained as long as there is any tendency to the formation of adhesions in the sheaths of the tendons. As the hand becomes stronger, the part of the splint supporting the fingers may be cut off. The patient must continue to use some support as long as he feels any weakness in the wrist. There is often some tendency to dropping of the wrist to the ulnar side, which is best counteracted by a properly constructed gutta-percha splint. The thumb is apt to be drawn in towards the index finger ; this must be prevented by a thick pad of lint kept from the earliest time between the two.

The essential points are, first, exact attention to all the details of the operation, and next, a careful and patiently conducted after-treatment.

Results.—Since Lister described his method of operating, excision of the wrist for disease has become a recognized operation of Surgery, and has been practised successfully by West (five cases), Gillespie, and many other Surgeons. In military surgery, however, according to the statistics of the American war, the results of the operation have been far from encouraging in regard to the amount of mobility left to the hand.

HAND.—In the removal of diseased or injured portions of the hand, it is, as a general rule, of the greatest importance to sacrifice as little as possible of the healthy or uninjured structures. In all operations on the hand, indeed, we must keep two great principles in view—the preservation of the utility of the member, and the maintenance, so far as practicable, of its symmetry. Utility is necessarily the primary consideration ; but if a part be not useful, it may, as in the case of the head of the middle metacarpal bone in amputation of the corresponding finger, be sacrificed for the purpose of preserving the symmetry of the maimed limb. The hand is the organ of *prehension* and of *touch ;* and in all operations applied to it we should endeavour, as far as practicable, to maintain its efficiency in both these respects. It is also of importance to bear in mind that two great classes of actions can be carried out by the hand—those that require force, and those that require delicacy of manipulation rather than strength. By a surgical operation we may sometimes succeed in preserving one, though we are compelled to sacrifice the other. Thus, by partial excision, we may leave a hand that would enable a clerk to hold his pen, though it would be almost useless to a labourer or blacksmith.

We may consider the hand as being composed of two constituents—the hand proper, and the *Thumb ;* the thumb being an opponent to the rest of the member, without which its utility is comparatively limited. Hence in all cases of injury or disease implicating the thumb, every effort ought to be made for its preservation. Even if it be left stiffened and incapable of flexion at the interphalangeal joint, it will be a most useful opponent to the rest of the hand. Should it be found necessary to shorten it, care must be taken that as little curtailment as possible be practised ; a portion of a phalanx, or its metacarpal bone even, is of essential utility in giving strength and breadth to the grasp of the hand. In cases of disease, a very useful member may be left by the removal of a portion or the whole of the ungual phalanx, of the metacarpo-phalangeal articulation, or even by the excision of the metacarpal bone, the phalanges being left. These various operations are easy of performance; an incision through the diseased and disorganised soft parts will expose the necrosed bone or carious joint, which must be removed by cutting-pliers or a narrow saw.

When the thumb has been forced back, or badly lacerated by powder-flask or gun-barrel explosions, it may often be saved by being replaced and maintained in position on a splint, with some form of antiseptic dressing applied to it; and, should amputation be required, it must be done in accordance with the rule just mentioned—of saving as much as possible of the injured part.

In the conservative surgery of the **Fingers** the preservation of flexion and extension in the part left is the main thing to be aimed at; a rigid stump is always in the way. The preservation of these movements becomes more important in proportion as the palm is approached. It is of more consequence that the proximal phalanx, which carries the rest with it, should be capable of being bent into the palm, than that the distal can be flexed on the second. If the proximal phalanx can be bent down, a very small degree of movement in the distal one will be sufficient to furnish pliability enough in the finger to make it a useful member; but if the proximal one be stiffened, no amount of mobility in the distal phalanx can make it useful.

In preserving these movements, it is necessary to be particularly careful of the sheaths of the tendons. If they be in any way opened or injured, it will generally be found either that the tendon sloughs, or that it becomes adherent to its sheath in such a way that movement is lost, or greatly impaired.

The only phalanx that can be excised with advantage is the distal one. It often happens, in the destructive disorganization which results from whitlow, that this necroses; when, instead of amputating the end of the finger, it may be removed by an incision on its palmar aspect. Disease of the phalangeal articulations usually leads to amputation of the affected finger. The rules for performing these various operations have already been laid down at pp. 91 *et seq.*, Vol. I., to which I must refer the reader.

Resection of the **Metacarpal Bone**, either of the thumb or index finger, without the removal of the corresponding digit, is occasionally required, more particularly in cases of injury; it may readily be done by making a longitudinal incision over the dorsal aspect of the bone to be removed, carefully detaching it from surrounding parts by keeping the edge of the knife close against the bone, avoiding the tendons, and then either disarticulating, or (what is preferable) cutting across the neck of the carpal end of the bone, turning it out, and separating it from any distal attachments which it may retain. After the removal of the metacarpal bone of the index finger in this way, but little deformity results, and a very useful hand will be left, more particularly in children, on whom I have more than once practised this partial resection with success. If the periosteum be saved, the bone may be to some extent reproduced, but in order to obtain this result it is necessary to keep the finger drawn forwards by an elastic extending apparatus, to prevent the first phalanx from being pulled back on to the carpus by the muscles attached to it.

CONSERVATIVE SURGERY OF THE LOWER EXTREMITY.

In all conservative operations that are practised on the lower extremity, it is of essential importance that a good basis of support, of sufficient length and stability, be left to the body. These operations differ thus in some important respects from those that are practised on the upper extremity. In the latter, the preservation of the hand, even though in a mutilated condition, is the thing at which the Surgeon aims ; and, provided this be attained, it matters comparatively little how much the arm may be shortened or impaired in power. In the lower extremity, however, strength, length, and solidity are essential to the patient's comfort and utility, and unless these can be secured, his interests are better served by the removal of the limb, and the adaptation of some artificial contrivance, than by leaving a shortened, wasted, and crippled member, which is unequal to support the weight of the body.

Hip-joint.—Excision of the head of the thigh-bone may most conveniently be considered in connection with that affection (Chapter LII.).

Knee.—Excision of the knee-joint was originally performed at the close of the last century by Park, Filkin, and the Moreaus, but it fell into disfavour until it was revived in 1850 by Fergusson, since which time it has been extensively practised. During the last few years, since the operation has been robbed of many of its dangers by the improved methods of treating wounds, it has been performed more frequently than ever, and with steadily improving results.

Excision of the knee is undertaken in the great majority of cases for white swelling of the joint, but Surgeons differ considerably as to the period at which the operation should be performed. All are agreed that among the upper and middle classes, and in country practice, it should be employed only as a last resource, as a substitute for amputation, when all other means have failed to cure the disease. On the other hand, many Surgeons have become so disheartened by repeated failures to cure white swelling of the knee in the children of the poor of large cities, that they have resorted to excision at a very early period. It is not wise, however, to adopt a uniform mode of treatment for all cases ; each should be judged on its own merits.

The treatment of a case of white swelling of the knee should be conducted on the principles already laid down (p. 351) ; but a brief sketch of the points having special reference to this joint may not be out of place here. From the earliest stage, perfect rest of the joint is essential ; without this there is no hope of cure. This may be obtained by the application of some rigid apparatus, as the plaster of Paris or starched bandage, reaching from the fold of the nates to the toes, the patient being allowed to move about on crutches, without putting the foot to the ground. The most efficient apparatus is, however, the simple and ingenious splint, invented by H. O. Thomas, of Liverpool (Figs. 557, 558). Besides giving the most perfect rest, this has the great advantage of leaving the joint exposed so that the effects of the treatment can be observed, and, at the same time, it enables the patient to move about, as in Fig. 558. The apparatus consists of a well-padded iron ring, covered with leather, from which an iron rod extends downwards on each side of the leg, terminating in a second ring at the lower end. Attached to one of the iron rods is a piece of soft leather, which, when the splint is applied, may be brought up behind the limb, and secured to the other rod by being folded over it and fixed with strong pins. This leather is not essential, and in many cases the limb can be better fixed without it. The foot-piece represented in Figs. 557, 558, is required only when the splint is used to fix the limb after excision of the joint; in other cases it is not only useless, but injurious. In ordinary cases in which the limb is tolerably straight the apparatus is thus applied:—The splint must be of such a length as to extend from three to four inches beyond the foot. Two strips of strong strapping are prepared of sufficient length to reach from immediately below the head of the tibia to one inch beyond the sole of the foot; to one end of each of these a stout tape is firmly sewn. The strips are then applied to the sides of the leg, the tapes being below. To give additional security some narrower strips must be wound spirally round the leg, care being taken not to apply them circularly, or with sufficient tightness to constrict the limb. Over all, a flannel-bandage may be applied from the ankle to the upper end of the tibia. The strips of plaster thus applied, if of proper quality, should retain their hold without shifting for many weeks. The limb is then passed through the upper ring of the splint, which is pushed upwards till it gets a firm bearing against the tuberosity of the ischium. The splint is then secured in position by tying the tapes attached to the strips of plaster to the ring at the bottom of the splint. It is not intended in so

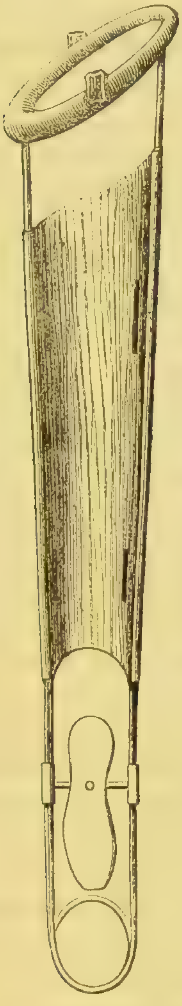


Fig. 557.—Thomas's Knee-Splint.

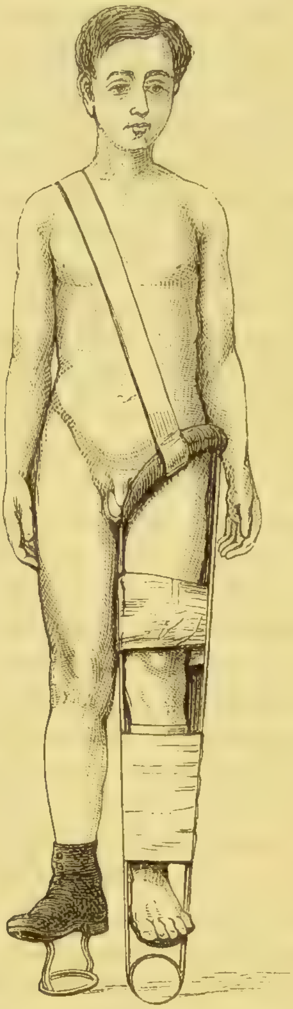


Fig. 558.—Thomas's Knee-Splint applied.

doing to forcibly extend the limb, but merely to retain the splint steadily in position. If the patient is to walk on the splint it is better to have a bar fixed across between the two vertical rods, about one inch above their lower ends, to which the tapes can be made fast, otherwise they are quickly worn through. The limb being thus fixed longitudinally, lateral and anterior posterior movements are prevented by two broad strips of plaster, about three feet long and three to five inches wide ; one to be applied to the middle of the thigh, and the other to the leg opposite the calf. The strip of plaster is first fixed to one of the lateral rods, then brought over or under the limb, and back to the same bar, the remainder of the strip being wound round, including both bars and the limb. The second strip is then applied in the same way, but is fixed to the opposite lateral rod. A broad strip of bandage or plaster is then applied behind the knee between the two lateral rods, so as to support the ham. This is not necessary if the leather is fixed to the splint, as in Fig. 557. Lastly, a flannel bandage is smoothly applied from the toes to the groin. If properly put up the apparatus should not require changing for some weeks ; the tapes must be tightened whenever they become loose, and the flannel bandage re-applied daily, but the strapping should not be touched. In walking, a patten is worn on the boot of the sound side, so as to equalize the length of the two limbs (Fig. 558). A broad strap may be carried from the splint over the opposite shoulder, as in Fig. 558, but if the strips of plaster are properly fixed to the leg, and the tapes tied sufficiently tightly, this is not necessary. A Thomas's splint applied as above described is perhaps the most perfect apparatus ever invented for fixing the knee. If, however, all the details are not attended to, it becomes as useless as any other form of splint. Even if the limb is flexed to a considerable angle, the Thomas's splint may be applied as above described, slight modifications being made to suit the altered position of the limb. After a few weeks in bed the limb will usually become straight, if no ankylosis exists.

During the time that the limb is on the splint the accessory means of treatment, such as counter-irritation or pressure by an elastic bandage, may be employed, should they be considered necessary ; but in most cases simple rest is all that is required. If the joint improves under this treatment it must be patiently continued for many months, or even a year or more. Should the joint continue to enlarge and abscesses form in spite of the treatment, or should the joint be seen for the first time after these complications have arisen, operative interference is required. It is not necessary, however, to have immediate recourse to excision or amputation, if the general health of the patient is good and his surroundings are favourable. If chronic abscesses have formed in the joint, and more especially if they have already opened superficially and are discharging through sinuses, an attempt may be made to save the joint by free lateral incisions made as far back as possible so as to drain the cavity thoroughly. If they are made too near the patella a pouch is left behind the incision on each side, in which the discharges may accumulate. The incisions should extend from the level of the upper limit of the pouch of synovial membrane above the patella to the level of the tibia. If an abscess be found burrowing beyond this point, the knife must be carried further, so as to lay it freely open. The incisions having been made, the pulpy granulation-tissue filling the cavity of the joint may be freely scraped away with a sharp spoon, and if a carious patch be felt on either of the bones this also may be treated in the same way. In some cases sequestra may be found, and removed. By this mode of treatment good results have been obtained by H. O. Thomas and Rushton Parker of Liverpool. It is specially adapted to children under fourteen or fifteen years of age, and the younger the child the better hope there is of success. In adults it is rarely to be recommended ; nor is it practicable when the bones are extensively destroyed. The operation should be performed with the strictest antiseptic precautions. In the after-treatment drainage-tubes are not necessary if the incisions are sufficiently free. The dressing must be changed at the end of the first twenty-four hours, as it will be soaked by the abundant bloody and serous discharge which flows away immediately after the operation. An antiseptic cotton-wool dressing, either of iodoform- or salicylic-wool may then be applied, enveloping the knee widely on each side, and surrounding the splint. This may be left undisturbed till some discharge soaks out, unless severe pain or elevation of temperature indicate that all is not going on well. König strongly recommends the application of some iodoform to the inside of the joint at the operation. Should the treatment fail to arrest the disease, the incisions can be utilized in a subsequent excision or amputation.

In cases in which there is much pulpy and fungating granulation-tissue filling the joint, especially in children, the operation of **arthrectomy or erasion of the joint** may be performed with a good prospect of saving a useful limb. This operation was first performed in this country by Wright of Manchester in 1881, and has also been recommended by Ollier and Volkmann. It is thus performed. The limb having been made bloodless by Esmarch's method, the cavity of the joint must be fully exposed. This may be done by a curved incision, extending from the posterior and upper part of the inner condyle to the corresponding point on the outer side, and extending downwards to a point about half an inch above the tubercle of the tibia. The ligamentum patellæ is then divided and the flap with the patella raised, fully opening the joint. Another method consists in making two lateral incisions extending on each side from the level of the upper part of the condyles of the femur to the head of the tibia. These are connected by a transverse incision passing over the middle of the patella. The bone is then sawn through, and the flaps turned upwards and downwards. Other methods have been suggested, in which the patella and ligamentum patellæ are uninjured, but it is scarcely possible to expose the joint efficiently without dividing one or the other. The next step in the operation is thus described by Wright. It "consists in carefully cutting away with forceps and scalpel or scisssors every particle of pulpy granulation-tissue, all the infiltrated capsule and the semilunar cartilages, and scraping quite clean all the articular cartilages, picking out granulation-tissue from any pits in the cartilage, and if necessary gouging away any small spots of diseased bone. The process must be thorough, and extreme flexion of the limb is required to completely expose and clean the posterior part of the joint ; the crucial ligaments are scraped but carefully preserved, the lateral ligaments are usually divided. The upper synovial sac must be thoroughly cleaned. The most difficult part of the operation is getting away the posterior part of the semilunar cartilages and the synovial membrane at the back of the joint. The process is a tedious one, often lasting one and a half or two hours—including the subsequent putting up in a splint." Other Surgeons have divided the crucial ligaments in order to reach the back of the joint, subsequently uniting them by catgut sutures. When the operation is completed, if the open mouths of any vessels can be seen they may be secured with catgut ligatures. The wound may then be closed. If the ligamentum patellæ has been divided it must be united by thick catgut sutures. The patella, if sawn through, may be brought together in the same way, or silver-wire may be used. It is very important to avoid the use of drainage-tubes. This may be done by making the incisions far enough towards the posterior part of the lateral aspect of the limb, and by sewing it up only in the middle, leaving at least two inches on each side to unite by granulation. An antiseptic dressing of some kind must then be applied. The following will be found very efficient. The wound is first dusted with iodoform; it is then covered with a strip of carbolized oiled silk to prevent scabbing; over this are placed four layers of carbolic gauze, wrung out of carbolic lotion, so that the early discharge may come directly in contact with a powerful chemical antiseptic during the first twenty-four hours. Over this again is placed a layer of iodoform- or salicylic-wool about one inch thick, and secured with an antiseptic bandage applied with moderate firmness. The Thomas's knee-splint can then be put on (p. 399). A large mass of salicylic wool many inches in thickness is then wrapped round the limb so as to include the splint, and to reach from the middle of the leg to the middle of the thigh, and over this a bandage is firmly applied so as to exert moderate elastic pressure. The limb is then elevated to a right angle and the tourniquet removed. If no bleeding occurs, the dressing may be left unchanged for a month or six weeks if the temperature remains low and no discharge appears. This mode of treatment has been adopted in a considerable number of cases in University College Hospital. In none has it been necessary to remove the dressing on account of hæmorrhage, and in the great majority the wound has been found healed or merely superficial at the first dressing a month or more from the operation. The essential conditions for success are, 1. Efficient antiseptic precautions; 2. Thorough removal of the diseased tissues; 3. Drainage without tubes by leaving some inches of the wound open; 4. The use of an efficient splint to ensure absolute rest; and, 5. A lasting dressing. In some exceptional cases the patient has recovered with a fairly movable joint, but more commonly firm fibrous ankylosis results. The operation presents great advantages over excision. The limb is not shortened, and as the epiphyses are not damaged, growth is not impaired.

When the foregoing methods fail, or in cases not adapted to the treatment by incision, or arthrectomy, excision of the joint or amputation becomes necessary to save the life of the patient.

Excision of the knee-joint may be practised also in cases of faulty ankylosis resulting from old disease or injury, by which the limb has been rendered useless.

Excision of the knee-joint may be performed by making a horse-shoe incision with the convexity downwards, commencing at the side of one condyle of the femur, and passing immediately above the tubercle of the tibia to a corresponding point on the opposite condyle (Fig. 559). By this incision the ligamentum patellæ is divided, and the patella turned up in the elliptical flap; the crucial ligaments, if not already disorganized, are then to be cut across, any remaining lateral attachments divided, and the bones cleared for the saw. In doing this the limb must be forcibly flexed, and the knife carefully applied to the posterior part of the head of the tibia; for this purpose a blunt-pointed resection-knife is the best. The articular surfaces must now be sawn off. This may be done with Butcher's saw; but in order to ensure a perfectly smooth section of the bones, it is better to use a common saw somewhat broader than that ordinarily employed in amputations. The lower end of the thigh-bone should first be removed. The saw-cut may safely be carried from before, backwards, or in the opposite direction, as there is no danger of injuring the popliteal vessels. It must be made accurately at right angles to the shaft of the femur, in the antero-posterior direction; but, in the transverse, it should be parallel to the articular surface, that is to say, the inner side must be left slightly the longer, as the internal condyle is naturally longer than the outer. If the condyles retain their normal shape, it is not difficult to judge the proper angle at which the saw should be held; but if they are extensively and irregularly destroyed, the following guide may be taken. The patient lying flat on his back, the thigh is flexed to a right angle, and adducted till the inner side of the knee corresponds to the middle line of the body; the saw is then to be held parallel to the surface of the table. A thin slice is next taken off the tibia. It is usually recommended to cut from behind forwards (Fig. 560) to avoid wounding the popliteal vessels; but if ordinary care be taken there is no risk of doing this, and it is more convenient to saw in the opposite direction. The section must be accurately at right angles to the shaft of the tibia in both directions.

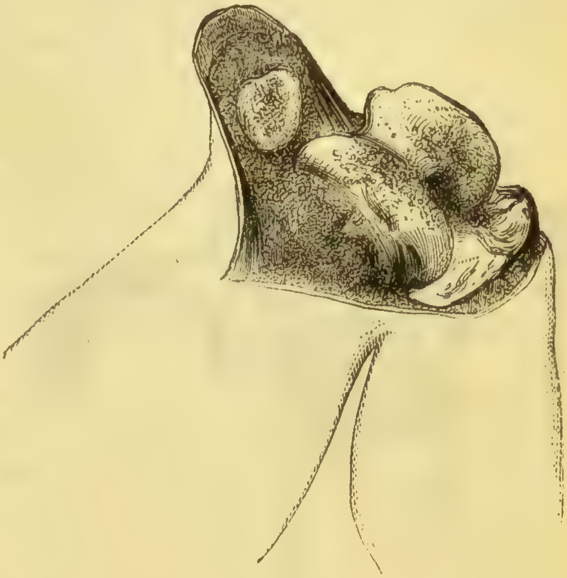


Fig. 559.—Elliptical Incision in Excision of the Knee-joint.

It has been recommended to saw the tibia concave and the femur convex, using a Butcher's saw, but it is difficult to do this so that the bones shall fit accurately, and the method presents no advantage over the ordinary way of operating. Care must be taken not to remove more of the bones than is absolutely necessary, especially in young subjects, lest the epiphyses be completely removed, and the growth of the limb interfered with. It is usually sufficient to remove from one-third to three-fourths of an inch of the tibia, and about one inch or an inch and a half of the thigh-bone (Figs. 561 and 562). In young children the ends of the bones can sometimes be sliced off with a knife, and the amount taken away accurately limited to the diseased tissues. It not unfrequently happens that carious cavities are found extending below the level of the section that has been made; when this is the case, it is better to apply the gouge to them than to saw the bone below their level. Should the operation be performed for deformity consequent upon badly reduced fractures or dislocations about the knee, as has been done successfully by Humphry of

Cambridge, it may be necessary, in order to bring the limb into good position, to remove a wedge-shaped piece from one of the bones.

If the patella be much diseased, it must be removed; if it be only slightly carious, it may be scraped or gouged out; and if healthy, in accordance with that principle of conservative surgery by which no sound part is removed, it should be left, becoming consolidated with and strengthening the joint. The articular surface for the patella on the thigh-bone, which extends some way up its forepart, may advantageously be sliced off, so as to leave an osseous surface, instead of a cartilaginous one, for the attachment of the patella.

I have always found the operation, as it has just been described, easy of performance and good in its results; but various modifications are adopted by different Surgeons. Thus, some make one straight transverse incision; others two parallel incisions, one on each side of the patella, or an H-shaped incision, and thus open the articulation from the side. Jones of Jersey, who had great experience in this operation, advised that the skin be dissected up by means of a semilunar incision, and then that the ligamentum patellæ be preserved by being pushed with the patella and the quadriceps extensor tendon to one side, the joint then opened, and the bones sawn. Others advise that the patella be always removed. Volkmann recommends a straight incision, passing from one condyle of the femur to the other, transversely across the middle of the patella, which is then sawn through, so as to expose the joint. After the articular ends of the femur and tibia have been removed, the fragments of the patella are united to each other by sutures of catgut, carbolized silk or wire. If its articular surface is diseased it must be sliced off or scraped. The results obtained by this method are very good; the patella readily unites by bone, and either remains movable or becomes fixed to the femur. The attachment of the quadriceps extensor and ligamentum patellæ being undisturbed, the tendency to displacement of the tibia backwards after the operation is counter-

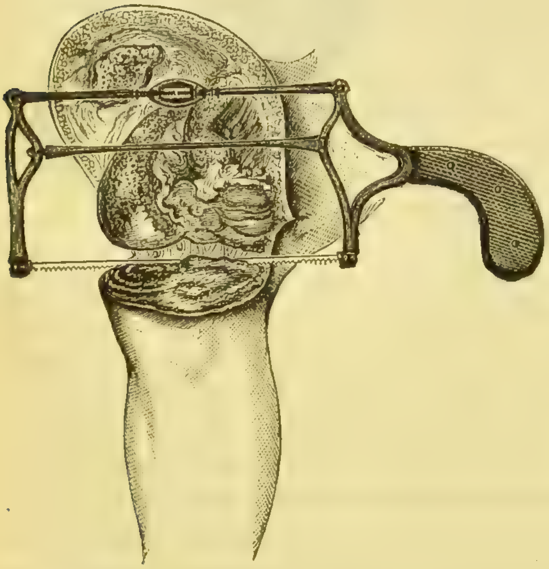


Fig. 560.—Application of Butcher's Saw to Head of Tibia.

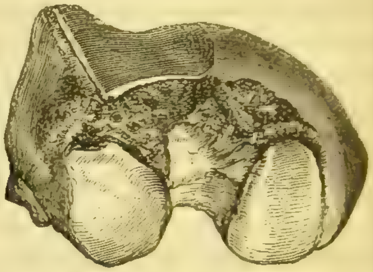


Fig. 561.—Lower End of Femur, excised.

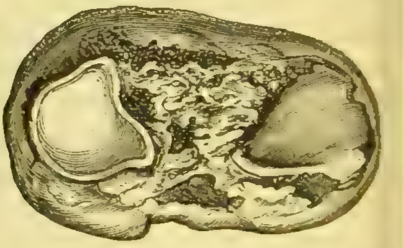


Fig. 562.—Upper End of Tibia, excised.

acted, and in walking the action of the rectus in bringing the limb forwards is preserved.

After the ends of the bones have been removed, in cases of white swelling, the pulpy granulation-tissue representing the synovial membrane must be cleaned away as completely as possible, partly by scraping with a sharp spoon and partly by the use of scissors and forceps. Some caution is necessary in cleaning the posterior part of the joint to avoid wounding the popliteal vessels. The healing of the wound is much facilitated and the subsequent suppuration diminished by this proceeding. If sinuses existed before the operation, they may be scraped and cleaned with a solution of chloride of zinc.

In order to keep the bones in position some Surgeons drill them obliquely at the anterior part and secure them by a couple of strong sutures of catgut, carbolized silk or wire. Strong catgut answers the purpose very well, and will not soften for about two weeks, after which time it is no longer needed. If the wound is not aseptic wire-sutures are the best, if any be used.

It is very important that all hæmorrhage should be thoroughly arrested before the wound is closed. In some cases no ligatures will be required, but usually two or three of the articular arteries furnish sufficient hæmorrhage to require restraint. The flap when laid down will often appear inconveniently long and thick, but it must not be curtailed, as it will eventually contract and fit well. As a rule drainage-tubes are not necessary, and the flap having no tendency to become displaced, only requires a few sutures to hold it in position.

The result of the operation will depend mainly on the care taken in the after-treatment and in the successful prevention of decomposition in the discharges. It is essential for success that the limb should be kept at perfect rest for the first few weeks ; any apparatus, therefore, which requires complete removal for dressing the wound should be avoided. A narrow splint of japanned iron extending from the buttock to the heel will usually answer the purpose sufficiently well. It must be padded where it is in contact with the thigh and the calf to such an extent that it is not in actual contact with the skin in the ham. It must be fixed in position by a flannel-bandage above and below the knee, over which a firm plaster-of-Paris bandage must be applied. Heron Watson recommends a soft iron rod or bar, applied anteriorly, reaching from the groin to the toes. The upper part is straight for the thigh, in the middle is an arch passing over the knee ; the lower part is straight for the leg, and bent at an angle forwards opposite the ankle to fit the dorsum of the foot. At the lower end opposite the ankle is a hook by which the limb can be suspended. This splint having been properly padded, is fixed in position with a plaster-of-Paris bandage. Thomas's splint with a foot-piece (Fig. 558) will also be found a very efficient apparatus, and may be secured above and below the knee with a plaster-of-Paris bandage. By any of these means the limb may be immovably fixed, while the knee is sufficiently exposed to allow of dressing. Whatever apparatus is chosen, it must be applied while the patient is still under chloroform before leaving the operating table. As soon as the wound is healed, the limb may be completely encased in a plaster-of-Paris or starched bandage till the bones are firmly united to each other.

If proper attention be not paid to the position of the limb, bowing outwards is apt to take place. In order to prevent displacement, it has been proposed to divide the hamstring tendons ; this, however, is never necessary.

The best dressing for an excision of the knee is that which requires changing least frequently, and most efficiently prevents decomposition of the discharges. That described as suitable to cases of erasion or arthrectomy (p. 401) can often be used with great advantage. Whatever dressing be used, the maintenance of perfect rest is absolutely essential. If this be attended to, osseous ankylosis will ensue, and a good and useful straight limb result. In two cases I have succeeded in getting a good limb with a partially movable joint; both these cases were in children, and I am disposed to think that in young patients this result may often be satisfactorily attained. In adults, however, osseous ankylosis should always be aimed at.

Selection of Cases for Excision.—It is generally recognized that excision of the knee should not be undertaken after the age of 30. Gant has recorded cases successfully operated on as late as 53, but these are quite exceptional. Excision is not as a rule to be recommended in very young children, as it is apt to arrest the growth of the limb to such an extent as to render it useless in after-life. Moreover, incision of the joint or arthrectomy is usually successful at this age. About 14 or 15 is considered by most Surgeons the most favourable age for the operation. It should not be undertaken when there is any visceral disease, especially if there is tubercular disease of the lungs or albuminoid degeneration of the liver. Extensive disease of the bones is unfavourable to the operation. It need hardly be said that the operation should not be undertaken when there is hope of cure by simpler means. In the International Congress of 1881 Kocher of Berne maintained that in white swelling excision of the knee ensures a more rapid cure and a better limb than any conservative method of treatment, but this view is not generally accepted. If the disease is recognized sufficiently early, and treated properly by perfect rest of the joint, excision should be required only in exceptional cases.

Results.—These have to be considered from two points of view: 1. The danger attending the operation, and 2. The utility of the limb left after it.

1. Statistics have been very abundantly published with regard to excision of the knee, with the object partly of showing the absolute mortality and partly of contrasting excision with amputation. The general result of the older records was to show that about 30 per cent. of all excisions of the knee were fatal chiefly from septicæmia, pyæmia and exhaustion from prolonged suppuration, and that the mortality after amputation for disease of the knee was about the same. This heavy death-rate has, however, been greatly reduced, partly by the operation being undertaken at an earlier period, and not only as a last resource in order to save life, and partly by the modern improvements in the treatment of wounds. The following may be given as examples of later results. Holmes states that at Guy's Hospital, where some of the Surgeons are strong advocates of early excision performed with antiseptic precautions, 89 joints were excised in a period of 5 years with only 6 deaths. Kocher, also an advocate of early antiseptic excision, in 1881 recorded 64 cases with six deaths, 3 from septic poisoning in the early days of the antiseptic treatment, 1 from hæmorrhage, 1 from carbolic acid poisoning, and 1 from acute tuberculosis. Messing, in order to illustrate the effects of the mode of dressing, has collected 92 cases from the hospital at Kiel; 21 were performed before the introduction of the antiseptic treatment, of these, 7 died directly from the operation; 23 were treated by antiseptic methods involving frequent change of dressing, and of these 2 died; the remaining 48 cases were

treated by the lasting antiseptic dressing, and of these only 1 died, from hæmophilia. Of the 92 cases, 14 underwent subsequent amputation. Sack of Dorpat, in 1880 published the results of 144 cases treated antiseptically by various Surgeons; of these, 25 or 17·3 per cent. died; 4 from infective processes in the wound, 13 from tuberculosis and other general diseases existing before the operation, 1 from chloroform, and 1 from carbolic acid poisoning, 2 from causes unconnected with the operation, and 4 from causes not stated. Of the 119 who survived, 11 underwent subsequent amputation, making exactly 75 per cent. of successes and 25 per cent. of failures.

As in the present day amputation is only performed in those cases in which from visceral disease, extensive implication of the soft parts and bones or advanced age, excision is no longer practicable, no fair comparison can be made between the two operations as regards mortality.

2. The second point that has to be determined, is as to the *Utility of the Limb* after the Operation.

On this point, the result of recorded cases is in favour of the operation. In one of Park's cases, operated on in 1783, that Surgeon states that the patient (a sailor), seven years after the operation, "was able to go aloft with considerable agility, and to perform all the duties of a seaman." In some of the latter cases the result has been equally good. One of Jones's patients (a boy) "could run and walk quickly without any aid of a stick, could stand on the limb alone, and pirouetted and hopped two or three yards without putting the sound limb to the ground." In several of my own cases an excellent, strong and straight limb has been left, useful for all ordinary purposes. In a case which I examined seven years after the operation, the limb was well nourished, straight, firmly ankylosed, and but very little shortened. The patient, a lad of twenty, could walk eight or ten miles, and even jump and stand on the limb without the least pain, sign of weakness, or difficulty. In very young children the result of the operation is not satisfactory, the leg continuing shortened and wasted, not developing with the rest of the body. This is apparently due to and dependent upon the removal of the epiphysis of the tibia, on the integrity of which the growth of that bone is dependent.

After the operation, osseous ankylosis takes place with a firm cicatrix; the limb is shortened from one to three inches, according to the amount of bone removed, but by means of a high-heeled shoe this inconvenience is greatly remedied. It has been urged against excision of the knee-joint, that convalescence is tedious and prolonged; but this argument can with justice have but little weight. If a useful limb can be preserved to the patient, it can matter but little if a few additional weeks be devoted to the procedure by which it is obtained; and, indeed, it is a question whether in many cases the patient may not be able to walk just as soon after the excision of the knee-joint as after amputation of the thigh; for, as has been very properly remarked, though the amputation-wound may be healed in three or four weeks, it may be as many months before an artificial limb can be worn.

On the whole from the evidence before us, it may be concluded that whenever it is practicable excision is preferable to amputation, as involving less mutilation and but little more risk. In the statistics collected by Sack above quoted, 13 out of 25 deaths arose from visceral disease existing before the operation. If these cases had been submitted to amputation probably many of them would have recovered, and the death-rate of the excisions would have been reduced to under 10 per cent. The operation should not be put off too long, till the patient is exhausted by pain and discharge, and the tissues round the joint are perforated by numerous sinuses ; but, on the other hand, it can hardly be considered justifiable to resort to excision without a fair effort to cure the disease by simple treatment, and in many cases it is now replaced by incision or arthrectomy. Every case must be decided on its own merits, and the results obtained will be in proportion to the judgment shown by the Surgeon in selecting the proper cases. In a doubtful case there is another consideration which cannot be altogether discarded in enabling us to form a judgment as to the preferable operation. And it is this, that, in consequence of recent improvements in surgical mechanics, artificial limbs are now constructed of so durable and useful a character, as to supply to a great extent the loss sustained by amputation, and this more particularly if the limb have been removed early in life, when the patient can more readily adapt himself to new methods of progression.

BONES OF THE LEG.—The **Tibia** is very frequently the seat of caries in the upper and lower epiphyses, and of necrosis in the shaft, requiring partial operation for the removal of the diseased portions. Occasionally, as a result of acute necrosis, a very considerable extent of the shaft, indeed the whole of it, may be removed as a loosened sequestrum, from the interior of the periosteum, more or less consolidated and strengthened by the deposit of new bone. Such operations present nothing special, and the result is usually very satisfactory, the limb that is left being strong, useful, and sound.

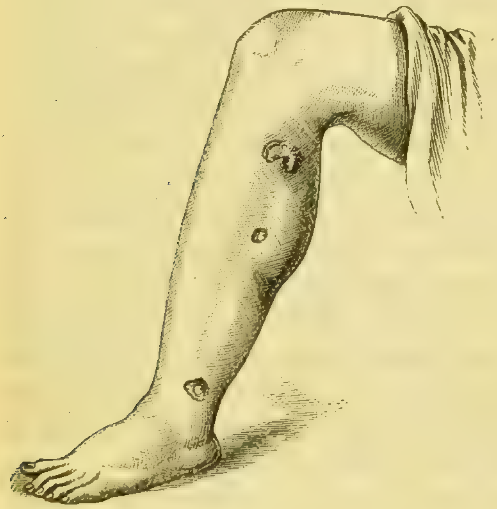


Fig. 563.—Limb with Necrosis of Fibula.

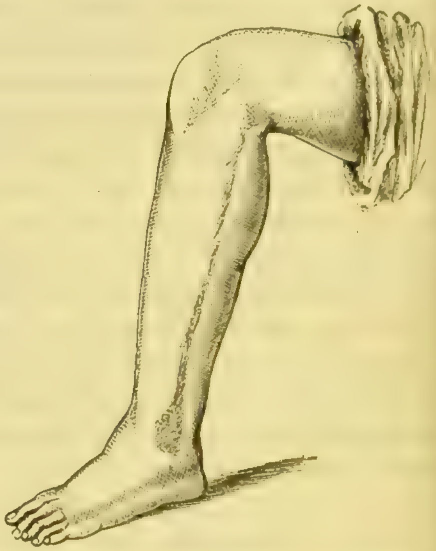


Fig. 564.—Limb after Removal of Fibula.

The **Fibula** is less frequently the seat of operation, but it, like the tibia may require partial removal. In one case, that of a child six years of age, I successfully removed the whole of the necrosed fibula. This operation is readily done by slitting up the sinuses in a direction so as to expose the sequestrum, which may then be drawn out without difficulty (Figs. 563 and 564). After the operation an inner splint must be applied, in order to obviate the tendency to varus which will ensue. In the case from which the annexed drawings are taken, very considerable repair took place from the periosteum and soft tissues along the line of bone that had been removed; and the child, when examined two years after the operation, had an excellent, well-nourished, and useful limb. The foot, however, had a tendency to be drawn inwards, apparently owing to the flexors having overcome the antagonism of the peroneal extensors. This deviation inwards was counteracted by the patient wearing a properly constructed boot, with which walking was perfectly easy.

FOOT.—In looking at the division of the foot into its three great component parts—toes, metatarsus, and tarsus,—we shall perceive that firmness of gait is given by the foot resting on the heel behind, and on the ball in front formed by the projection of the broad line of the metatarso-phalangeal articulations, more particularly that of the great toe; whilst elasticity is communicated to the tread by the play of the toes and metatarsal bones. The elasticity of the foot may be lost without any very serious inconvenience to the patient, but the preservation of stability and firmness are of essential importance; and as these are secured by the heel, the ball of the great toe, and the breadth of the anterior part of the foot, these are the most important parts to preserve in all resections of this part of the body.

In no region of the body have the good effects of modern conservative surgery been more distinctly shown than in the Tarsus. In the "good old times" of Surgery, if a person had a "white swelling" of the bones of the foot, or a diseased tarsus, he was at once condemned to amputation of the limb. No distinction was drawn between disease of the different parts of the foot, nor any attempt made to save the sound, by the sacrifice of the diseased, part.

Until a comparatively recent period, indeed, "diseased tarsus" was described as a whole. Surgeons did not endeavour to make out the exact extent and amount of the disease, and any case described as "diseased tarsus" was looked upon as requiring amputation of the leg. The rule of practice then observed was, amongst the wealthier classes—those who could afford the expense of a "cork leg"—to amputate a little above the ankle; but, amongst the poorer classes, to remove the leg about a couple of inches below the knee, so as to give the patient a stump which, when bent, would fit into the socket of a wooden pin. Thus, in the latter case especially, not only was the leg, itself perfectly sound, sacrificed, but the patient was exposed to great additional danger; for the mortality after amputation increases, *cœteris paribus,* in exact proportion as we approach the trunk. This practice continued to prevail until Chopart drew some distinctions between the treatment to be pursued, according as the disease affected the anterior or the posterior tarsal bones and articulations. He showed that, when the anterior articulations only were affected, amputation at the junction of the astragalus and calcaneum with the scaphoid and cuboid —an operation which goes by the name of "Chopart's amputation"—ought to be performed; thus removing the whole of the disease, and allowing the patient to recover with a shortened foot, with the heel preserved—one on which he could bear the weight of his body, and which would be highly useful to him.

The next step in the conservative surgery of the lower extremity, in cases of diseased foot, was the operation introduced by Syme—that of disarticulation at the ankle-joint. This was certainly a great advance; for, the flap being taken from the heel, the patient has a stump on which he can bear firmly The operation is also a very safe one. According to O. Weber, only 17 deaths occurred in 101 cases of this operation. I have performed it many times without a death.

Since the introduction of anæsthetic agents, Conservative Surgery has made great strides ; and I think Conservatism in Surgery may be regarded as the necessary result of Anæsthesia. For, although operations of this kind were performed years ago by Park, the Moreaus, and others, and their utility demonstrated, yet the operations of gouging, scraping, and partial resection were so horribly painful, and occupied so much time in their performance, that patients dreaded to submit to, and Surgeons declined to undertake, them. Of late years Surgeons have learned to discriminate disease of one part of the tarsus from that of another, and to apply appropriate treatment to each.

Looking at the subject from a diagnostic point of view—and the treatment is most intimately connected with minute and accurate diagnosis—we find that the pathology of diseases of the tarsus is closely connected with its healthy anatomy. Composed of seven bones, it presents four distinct articulations. By the term "articulation," applied to the tarsus, I do not mean merely the connection of contiguous bones with each other, but distinct synovial sacs shut off from communication with other synovial sacs in the foot. These are well represented in the annexed diagram (Fig. 565). The *posterior calcaneo-astragaloid* is the first of them ; next comes the (*a*) *anterior calcaneo-astragaloid*, the synovial membrane here serving also for the *astragalo-scaphoid;* the *calcaneo-cuboid* (*b*) is the third ; and the *anterior tarsal synovial membrane* (*c*) is the fourth and largest of all, and the most important in a surgical aspect. It extends between the scaphoid and the three cuneiform and the cuboid bones, between the cuneiform bones themselves, between the two outer cuneiforms and the bases of the second and third metatarsal bones, and also between the external cuneiform and the cuboid. The articulation between the cuboid and the last two metatarsal bones is shown at *d;* and *e* is that between the internal cuneiform and the first metatarsal bones. These two (*d* and *e*) are not, strictly speaking, tarsal joints.

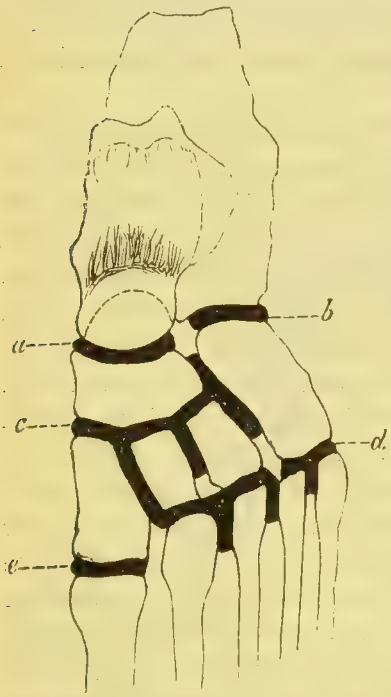


Fig. 565.—Diagram of Synovial Membranes of the Foot.

In the vast majority of cases, so far as my experience goes, it is the osseous structures, and not the articulations, which are primarily diseased. The bones, being cancellous, far removed from the centre of circulation, and exposed to alterations of temperature, readily become the seat of congestion and caries, but rarely of necrosis ; and in strumous subjects very commonly become infected with tubercle. Caries, once set up in bones, speedily implicates the articulations secondarily.

Now it will easily be understood, on casting an eye on the arrangement of the tarsal synovial membranes, that the extent of disease will, in a great measure, depend upon its original seat. Thus, a person may have disease in the os calcis, extending even to the cuboid, with very little likelihood of its proceeding farther for a length of time. Such disease is limited to the outer part of the foot, does not involve its integrity, and readily admits of removal by operation. But let him have disease springing up in the scaphoid, or in one of the cuneiform bones, or in the bases of the second or third metatarsal bones, and the morbid process will rapidly spread through the whole of the anterior and inner part of the tarsus, and, in all probability, no operation of resection can be advantageously employed. Hence the seat of disease influences materially its amount and extent, and the kind of operation required.

When the foot is affected by strumous disease it becomes painful, the patient being unable to bear upon the toes or anterior ball of the foot. Swelling of an uniform character takes place, with tenderness at some point opposite the bones or articulations that are chiefly involved ; and eventually abscesses form, leaving sinuses through which the probe passes down upon softened and carious bone. These evidences of disease are usually much marked about the dorsum and sides, where the bones are most superficial, the sole being often comparatively free—an important point in reference to operation.

The bones that are most frequently the seat of primary disease are the calcaneum, the astragalus, the scaphoid, the cuboid, and the metatarsal bone of the great toe. When the disease is limited to one or two of these bones, excision is usually practicable ; but when it extends, through the influence of the connecting articulations, to other bones of the tarsus or metatarsus, partial amputation will probably be required.

Primary disease of the articulations of the foot is a less frequent cause of operation than caries of the tarsal bones leading secondarily to an implication of the contiguous articulations ; and the particular operation required will, in a great measure, depend upon the extent of implication of the synovial membranes of the foot. When the calcaneo-astragaloid or the calcaneo-cuboid articulations are alone affected, with their contiguous bones, resection of the bones and joints implicated will often be attended by very satisfactory results ; but when the large anterior tarsal synovial membrane is in a state of chronic disease, either primary or secondary to disease of the scaphoid, the cuneiform, or of either of the metatarsal bones connected with it, then resection is scarcely admissible, and Chopart's amputation offers the best means of relief. Inflammation of the large and complicated anterior tarsal synovial membrane commonly commences in disease of the scaphoid. It may, usually, be recognized readily enough in its earlier stages by the pain and swelling that take place across the line of articulation between the scaphoid and cuneiform bones, the pain being greatly increased by bending the foot down, and extending across the whole breadth of the foot. Although it is usually most severe at the inner side, which is the first affected, yet the external section of this complicated articulation, that between the external cuneiform and the cuboid, becoming involved, causes pain in the outer side of the foot as well. In the more advanced stages of this disease, the foot assumes a remarkable bulbous or clubbed appearance ; the symmetry of the heel and the outline of the ankle are unimpaired, but the fore part and dorsum of the foot are greatly swollen, glazed, and sometimes perforated by sinuses discharging thin pus. I look upon this disease of the anterior tarsal synovial membrane as a distinct affection of the foot, requiring to be diagnosed from the other strumous inflammations, and in its advanced stages demanding Chopart's amputation.

It may be stated generally that the result of disease of the tarsus will be dependent mainly upon whether it is acute or chronic, progressive or stationary, diffused or limited. When it is *acute*, its limit cannot be defined, and after the removal of one portion the disease may be lighted up afresh in the structures, osseous or articular, that have been left. When *progressive*, there will be found be a general tendency to disease in, or disorganization of, the tarsal structures, and partial operation can be productive of little good. When it is *diffused*, extending into the large anterior tarsal or tarso-metatarsal articulations, partial operation can avail nothing. It is in those cases in which the disease is *chronic, limited,* and *stationary*, or nearly so, that excision and partial operation can be beneficial. In cases of this last kind, more especially in young children, no formal operation of excision of any particular bone should be undertaken before an attempt has been made to cure the disease by scraping as described in the chapter on the Diseases of Bones (p. 289).

Excision of Tarsal Bones.—Any one of the tarsal bones may be the seat of primary disease, which may be limited to the bone originally implicated, or may extend to neighbouring articulations, or through the whole tarsus. There are, however, four bones which may be looked upon as the most frequent centres of tarsal disease—viz., the Os Calcis, the Astragalus, the Scaphoid, and Cuboid; and as regards frequency, they are affected in the order given.

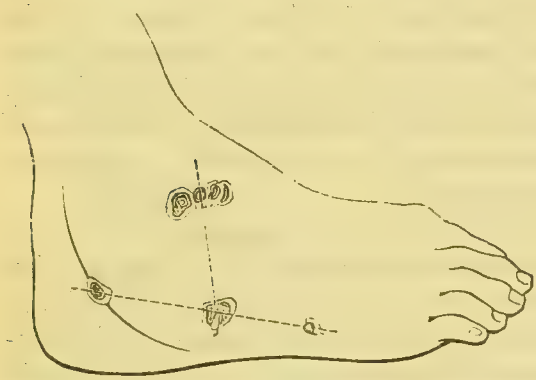


Fig. 566.—Disease of Os Calcis and Cuboid, and of Calcaneo-Cuboid Joint: Lines of Incision.

The **Os Calcis**, from its exposed situation, large size, and spongy structure, is more frequently the seat of caries and necrosis than any of the other tarsal bones. Very commonly the disease is limited to this bone; in other instances it extends into the calcaneo-astragaloid or calcaneo-cuboid articulations.

When the disease is situated in the *posterior* or *lateral part of the bone*, the neighbouring articulations are seldom involved, and then the removal of the morbid structures by gouging or scraping with sharp spoons will usually succeed in effecting a cure. I have frequently had occasion in this way to scoop out great portions, sometimes the whole of the interior of the calcaneum, with the most excellent results. Even when the cuboid is extensively implicated as well, and the calcaneo-cuboid articulation is the seat of disease, the disorganized structures may often be removed by gouging and partial resection, as in the case of which the cut (Fig. 566) is a good representation, where, by means of a ⊥-shaped incision, these bones were exposed, and their carious portions gouged out. Should, however, the caries have affected the *superior* or *anterior portions of the bone*, then the implication of the astragaloid or cuboid articulations may render the excision of the whole bone necessary, as the only means of preventing extension of secondary mischief to the tarsus generally. So unfrequent, however, is disease of the articular aspects of this bone, that its complete removal is very seldom necessary. Out of at least fifty cases of caries of the os calcis that have been under my care, I have had occasion to excise the whole bone only once; and Fergusson states that he has never yet found it necessary to do this operation. Indeed, excision of the os calcis should not be lightly undertaken. The large size of the bone, its importance as a basis of support to the body, and as the point of attachment of the strong muscles of the calf, should induce the Surgeon, whenever practicable, to avoid its complete extirpation, and to limit himself to the application of the gouge, or sharp spoon, even though he may have to scoop out the whole of the interior of the bone, leaving little more than an osseous shell. This will fill up with dense fibroid tissue, which will probably, eventually undergo partial ossification, and leave the foot as useful as ever.

Operation.—Excision of the os calcis is usually performed by turning a heel-flap back, and then carrying incisions forward into the sole of the foot by which another flap is turned up, and the calcaneo-cuboid articulation exposed and opened ; after which the knife is carried between the astragalus and calcaneum, and the latter bone detached. By this operation the sole of the foot is somewhat extensively incised, and cicatrices are left over the heel.

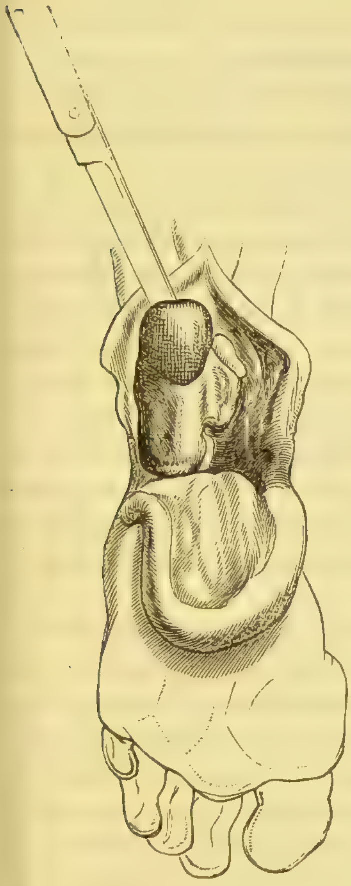


Fig. 567.—Excision of the Os Calcis.

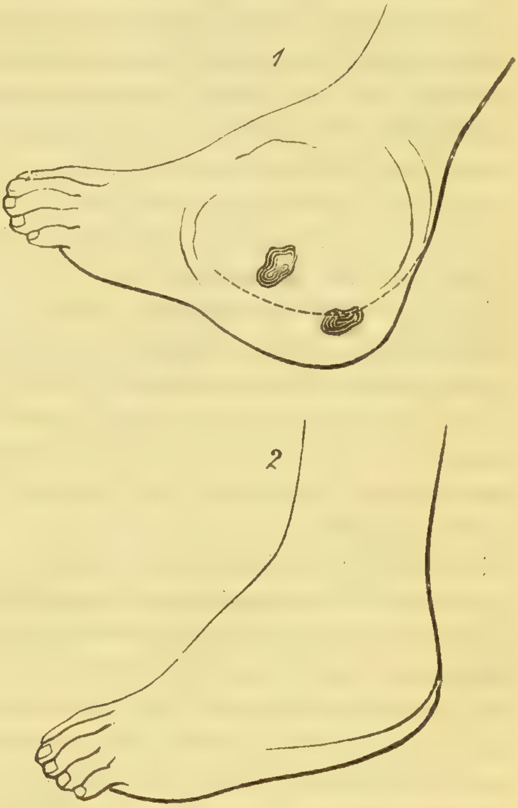


Fig. 568.—Disease of the Os Calcis.
1. Foot before Operation: 2. Foot after Excision.

In order to avoid this inconvenience, I have found that exarticulation of the os calcis may readily be performed in the following way. The patient lying on his face, a horseshoe incision is carried from a little in front of the calcaneo-cuboid articulation round the heel, along the sides of the foot, to a corresponding point on the opposite side. The elliptical flap thus formed is dissected up, the knife being carried close to the bone, and the whole under surface of the os calcis thus exposed. A perpendicular incision, about two inches in length, is then made behind the heel in the mid-line and into the horizontal one. The tendo Achillis is then detached from its insertion by the periosteal elevator and the two lateral flaps are raised if possible with the periosteum by means of the elevator, aided if necessary by the knife (Fig. 567). The knife is then carried over the upper and posterior part of the os calcis, the articulation is opened, the interosseous ligaments are divided, and then, by a few touches with the point, the bone is detached from its connections with the cuboid. This bone, together with the astragalus, must then be examined; and if any disease be met with, the gouge should be applied. Should ankylosis have taken place between the os calcis and the astragalus, the bones may readily be divided by means of Butcher's saw. By this operation all injury to the sole is avoided; and the open angle of the wound being the most dependent, a ready outlet is afforded for the discharges.

The drawing (Fig. 568) gives an excellent representation of the state of the foot of a girl before and after the excision of a diseased os calcis—a somewhat flattened but most useful foot resulting.

Ollier's Method.—Ollier has described a mode of removing the os calcis somewhat differing from the above. A curved incision, commencing on the outside of the tendo Achillis, at the level of the ankle-joint, is carried down as far as the external tuberosity of the os calcis, and thence along the side of the foot as far as the base of the fifth metatarsal bone. The flap being raised, the periosteum and tendo Achillis are separated from the bone, which is then further denuded of its periosteum as far as can be reached, the ligamentous attachments are divided, and the bone is removed. In fact, in caries of the os calcis, it may often be found, as in performing Syme's amputation, that the thickened periosteum strips off the softened and carious bone as readily as the peel off an orange; hence a formal process of dissection is scarcely needed.

History and Results.—Excision of the os calcis is a very successful operation. It seems to have been first performed by Monteggia in 1813; the result appeared promising, when the patient died of scrofulous disease. The operation then fell into abeyance for twenty-four years, when Robert, in 1837, in a case of necrosis of the bone, removed the diseased portion, leaving the healthy peripheral layer. The same Surgeon, in 1844, in a case of caries, removed the whole bone with the exception of its upper articular surface and the inner side of the body. Greenhow of Newcastle, in this country, and Rigaud, in France, appear to have been the first Surgeons who successfully excised the whole of the os calcis. Their cases both occurred in 1848; and since that time the operation has been performed in a large number of cases in this country and in America, and established as one of the many important developments made in late years by Conservative Surgery. In France, it seems to have met with little favour, though it has been successfully performed there in several instances, by Ollier, Giraldès, and some other Surgeons.

Polaillon, of Paris, in an able article written in 1869, with the object of advocating the performance of the operation, has collected the records of 64 cases. Of these he sets aside 9, of which he has not been able to find sufficiently accurate statements as to the result. Of the remaining 55, 39 were successful—this term implying that the patients were enabled afterwards to walk without artificial apparatus or support. Of the remaining 16, in 6, crutches or other apparatus were necessary; in 7, subsequent amputation was demanded on account of return of the disease or inutility of the foot; and there were 3 deaths. Resection of the entire bone—in a few cases with other portions of the tarsus—appears to have been performed in 39 of the 55 cases; of these, 30 were altogether successful; in 4, artificial support was necessary; 2 required subsequent amputation; and 3 died. The operation, according to Polaillon, has been more successful in children than in adults. He states that, of 12 cases under 10 years old, all were successful; between the ages of 10 and 20, there were 14 successful cases, and 3 failures; between 20 and 30, 7 successes and 9 failures; and between 30 and 40, 6 successful cases and 3 failures. Reproduction of the bone occurred in 12 cases; 11 being in individuals under 20 years of age.

The **Astragalus** is situated in a position of great surgical importance. Articulating with the malleolar arch above, with the calcaneum below, and with the scaphoid in front—forming, as it were, the keystone of the foot—it is perfectly evident that any disease commencing in it is very likely to spread to and involve all the more important structures of the foot. Seldom, indeed, does disease originating in this bone long remain confined to it; and, so far as my experience goes, gouging operations, even if performed at an early period, are rarely of much benefit, the morbid process continuing to extend notwithstanding their employment. Indeed, in diseased astragalus, I believe that excision ought, as a rule, to be practised in preference to gouging, contrary to what is the case in the calcaneum.

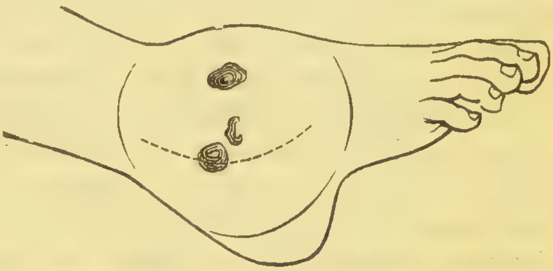


Fig. 569.—Disease of Astragalus.

Disease primarily originating in the astragalus may spread in three directions: upwards into the ankle-joint, downwards to the calcaneum, forwards to the scaphoid, and thence through the large anterior synovial membrane to the rest of the tarsal bones. The treatment will vary according to the direction and extent of the disease. It may be arranged under four heads.

1. When the *astragalus alone is diseased* we find what is seen in the drawing (Fig. 569), which represents the foot of a boy whose astragalus I excised—swelling just in front of the malleolar arch, with fistulous openings leading down to the diseased astragalus; the anterior part of the foot and the heel being quite sound. If the disease be limited to the outer side of the bone, or to its head, it is possible that, by freely opening the sinuses and applying the gouge, the caries may be entirely removed. But this operation is not so satisfactory here as elsewhere in the foot, as it is by no means easy to avoid opening the astragalo-scaphoid articulation; and if this be done, disease will probably extend through the tarsal articulations. Excision of the astragalus alone, though sometimes required for disease, is perhaps more frequently called for in those cases of compound dislocation in which the bone, having been thrown out of its bed becomes carious or necroses.

The operation of excision of the whole of the astragalus for disease may be done as follows. A curved incision, from four to six inches in length, should be made immediately behind the outer malleolus, and carried forward on the outer part of the dorsum of the foot to opposite the fore part of the bone.

The divisions of the external lateral ligament of the ankle-joint are then cut across, and the tendons of the peroneus brevis and tertius, and the extensor brevis digitorum muscle, divided. But the mass of extensor tendons in front of the foot, with the dorsalis pedis artery, must be left untouched. These should be drawn forcibly inwards. The peroneus longus tendon may be drawn backwards. The foot is then strongly twisted inwards, the astragalus cleared, and its ligaments divided from the outer side in succession as they present themselves. When the operation is done for disease of the bone, these structures will usually be more or less softened and disorganized; when for injury, they will in a great measure have been torn through. Hence, in actual operation, the same steps cannot be followed so methodically as may be done on the dead subject. The bone must now be seized with lion-forceps and drawn well out of its bed; the knife being applied to any restraining structures, but being used very carefully towards the inner side of the bone, lest the plantar arteries be wounded. Under this process the softened and carious bone usually breaks down and has to be taken away piecemeal, or its neck may be cut across, and the head separately removed from its articulation with the scaphoid. If the bone have been dislocated, and its ligamentous connections thus torn through, or if these have been disorganized, and softened by disease, it may readily enough be removed as just described; but if the osseous tissue itself be softened, and the ligamentous connections tolerably sound, then the operation becomes extremely troublesome.

The *result* of this operation is very satisfactory; a good and movable articulation may be left between the malleoli and calcaneum, and the limb is but little shortened. According to Hancock, of 109 cases in which the astragalus was removed, 76 recovered with good and useful limbs; secondary amputation was performed in two, with one death; 15 others died; and in 14 the results are not known. The operation was performed in 64 cases for compound dislocation, with 50 complete recoveries; in 20 of simple dislocation, with 14 complete recoveries; and in 10 for caries, perfect recovery taking place in 6.

2. When the disease has **extended from the astragalus to the malleolar arch, excision of the ankle-joint** will be required. This operation may be performed in the following way. The limb being placed on its inner side an incision is made commencing about two inches above the extremity of the outer malleolus, and following the posterior border of the bone to its tip. It is then curved round the malleolus and carried upwards in front of the bone to a point nearly opposite that at which it commenced. This must be carried firmly down to the bone, which is then cleaned by means of an elevator, the periosteum being carefully saved and the tendons of the peronei pushed backwards but not divided. The fibula is then cut through with a fine saw about half an inch above the level of the ankle-joint, and the malleolar portion is removed. The foot is now turned on the outer side and a similar incision made round the inner malleolus. Esmarch recommends that from the middle of the curve a vertical incision shall be carried up the tibia for about two inches, but this is not necessary if the original incision is of sufficient length. The malleolus and the lower end of the tibia are now carefully cleaned with the periosteal elevator, the deltoid ligament being separated from the malleolus and the tendons raised and pushed on one side. The lower end of the tibia may now be sawn across with a narrow saw and extracted from the

inner wound. The saw may now be inserted again and the upper articular surface of the astragalus separated from the rest of the bone. No important vessels or tendons should be divided in this operation.

It very rarely happens, however, that the disease of the astragalus is so limited as to make the operation practicable. When it is more deeply affected it may be removed piecemeal by the gouge, elevator, and bone-forceps, after which any disease of the articular surfaces of the calcaneum or scaphoid may be scraped away. After the operation the limb must be placed on a suitable splint (Fig. 570).

Excision of the ankle-joint has also been performed by a single incision on the outer side. If this plan be adopted the incision must follow the posterior border of the lower arch of the shaft of the fibula and the outer malleolus, round the tip of which it must be carried and then extended upwards and forwards, so as to give as much room as possible without dividing the extensor tendons. The lower end of the fibula is then removed, after which the astragalus may be loosened from its attachments or dug out with the gouge and the tibia afterwards exposed by dislocating the foot inwards. This operation is only applicable to those cases in which from the extent of the disease it is necessary to remove the whole astragalus. If it is intended only to cut away its upper articular surface the single incision does not give sufficiently free access to the joint.

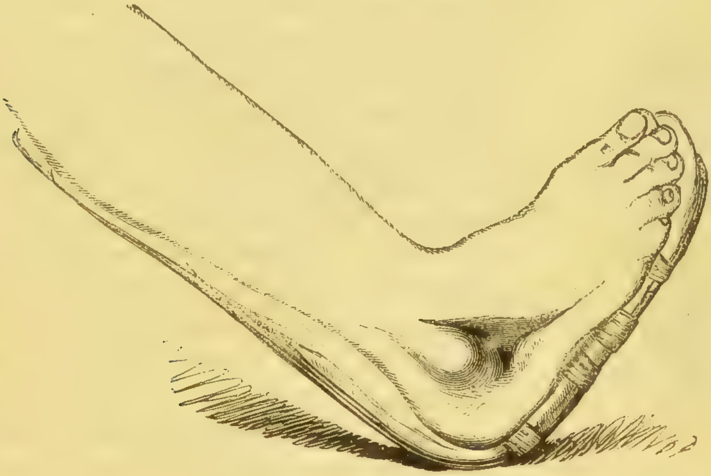


Fig. 570.—Limb after Excision of the Ankle-Joint.

3. When the disease has **extended from the astragalus upwards into the malleolar arch, and downwards into the calcaneum,** the line of practice will depend on the extent to which the os calcis is implicated. If the greater part or the whole of this be involved, no resource is left but amputation—resection not leaving a useful foot. If, however, the calcaneum be only partly involved, its upper surface only being affected, a great deal may be done by conservative surgery. The treatment in such cases consists, generally, in removing the astragalus from its bed, and gouging away any diseased bone which may exist either on the upper surface of the calcaneum or on the under surface of the malleolar arch. Very large portions of bone may be removed from this situation. I have taken away the whole of the malleolar arch and astragalus, and gouged out the upper surface of the os calcis very freely; and

yet the patient has recovered with a strong and movable foot, but very little deformed.

The accompanying cuts (Fig. 571) were taken from a young man on whom I performed the operation just described. The foot was perfectly useful and strong, and the false joint at the ankle movable.

The *result* of excision of the tibio-tarsal articulation is generally good. Spillman says that of 73 cases 50 were successful. Among these, the outer malleolus was removed in 22, one of which required secondary amputation, and 4 died. This leaves 51 cases of removal of the tibio-tarsal joint; in 12 of these, the disease was of traumatic origin, and the operation was successful in 11; in 37 it was constitutional, and of these 22 recovered, 7 died, 7 required secondary amputation, and in one the disease continued two years after the operation.

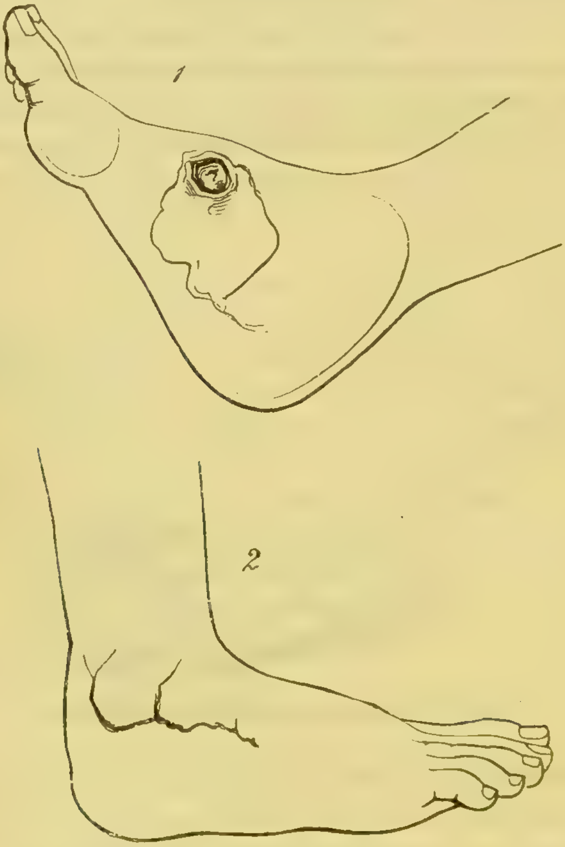


Fig. 571.—Excision of Astragalus. 1. Foot before Operation. 2. Foot Six months after the Removal of the Malleolar Arch, both Malleoli, the Astragalus, and a portion of the Upper Surface of the Calcaneum.

4. If the disease have **extended from the astragalus to the scaphoid,** and thence **into the anterior range of tarsal joints**, the foot will have become so extensively disorganized, that partial resection will be of little or no service; and disarticulation at the ankle-joint should be practised.

Excision of the **Cuboid Bone,** either in whole or in part, may be required. Partial excision is here done with the gouge. When the whole of the bone is taken away, the fifth metatarsal bone also, with the little toe, will probably require removal. This may be done by making the flap, as depicted in

Fig. 56, Vol. I., only commencing the incision about an inch further back, opposite the calcaneo-cuboid articulation, and opening this instead of the metatarso-cuboid.

The **Scaphoid Bone** is very commonly the seat of primary disease ; and, as this bone is connected in front with the large tarsal synovial membrane, and posteriorly with that which is common to the calcaneo-astragaloid and astragalo-scaphoid articulations, the greater part of the tarsus is apt to become speedily involved. The extent of this implication is such, that excision of the primarily diseased bone would probably seldom be attended by much benefit, and Chopart's amputation or disarticulation at the ankle-joint becomes necessary. Next to disease of the astragalus, I look upon strumous inflammation and caries of the scaphoid as most destructive to the integrity of the foot.

When the **Cuneiform Bones** are the seat of caries, it will generally be found that the middle is the bone primarily affected. Thence the disease extends to the lateral ones, or to the bases of the second and third metatarsal bones (Fig. 572). In such cases the anterior tarsal synovial membrane usually becomes extensively implicated, and Chopart's amputation will be required. But if the disease continue to be limited to the middle cuneiform and the contiguous metatarsal bones, and the patient's general health be good, removal of the affected osseous structures by the gouge, with extraction of the carious cuneiform, may be attended by successful results.

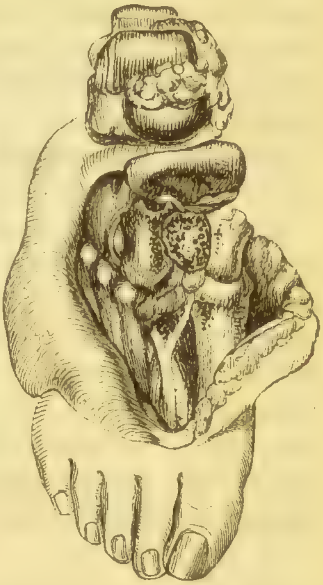


Fig. 572.—Disease of Cuneiform Bones.

Excision of more than one of the Tarsal Bones is sometimes required in chronic disease, and may leave an excellent limb. No formal rules for the operation can be laid down; the course of proceeding must depend on the nature of the case and the judgment of the Surgeon. In a lad who was many years since under my care with very extensive disease of these parts, I removed the lower three inches of the fibula, and gouged away considerable portions of the end of the tibia and of the astragalus, calcaneum, and cuboid—removing a whole handful of carious bone ; yet a perfect cure resulted, the patient recovering with a strong and useful foot. The os calcis with the astragalus was successfully removed by T. Wakley in 1848, and by Watson of Edinburgh ; and the os calcis, almost the whole astragalus, and a part of the scaphoid, by Nicholls of Chelmsford. Mulvany, in a case of disease of the tarsus consequent on compound dislocation, removed the greater part of the scaphoid, half the os calcis, all the astragalus, and the lower end of the tibia. Fayrer removed the articular ends of the tibia and fibula, the os calcis, astragalus, and scaphoid for disease, in a boy 9 years old ; and Lehmann of Polzin, in a case of caries in a man aged 40, removed by subperiosteal excision the entire os calcis, the astragalus, and the scaphoid bones, the foot having a perfectly normal appearance three months after the operation, and the patient being able to walk well, without a stick.

In infants and very young children, disease of the tarsal articulations and even bones may often be recovered from, without the necessity of having recourse to operation, by attention to the child's general health, and by giving the part rest.

The **Malleoli** alone seldom require resection. Should either of them do so, the operation may readily enough be accomplished, in the outer malleolus, by dividing the bone with cutting pliers; but in the inner malleolus, more care is required in avoiding the flexor tendons, the artery, and nerve, and the bone had better be cut across with a chain-saw. The periosteum should be saved as much as possible. The removal of the outer malleolus, or rather of the lower end of the fibula, is apt to be followed by a tendency to twist of the foot outwards—in fact, to a kind of valgus.

The **Metatarsal Bones with their Toes** occasionally require removal. This is more particularly the case with the first and the fifth (p. 110, Vol. I.). The middle metatarsal bones cannot advantageously be taken away, leaving merely the first and last; but the two, three, or even the whole four of the external metatarsal bones may be resected in early life, and a useful foot left. Aston Key has recorded a case in which, in consequence of injury, he amputated the four outer metatarsal bones, the cuboid, and the external and middle cuneiform, leaving merely the line of bones supporting the great toe, but a very good foot resulted, by which the patient retained in a great measure his elasticity of tread.

The **Phalanges and Articulations of the Toes** seldom require resection; as a general rule, their amputation is preferable.

The **Great Toe** not unfrequently requires removal, in whole or in part; but, as it enters largely into the formation of the arch of the foot, no more of it should be taken away than is absolutely necessary. It is especially of importance that the ball of the great toe, if possible, be preserved; and occasionally this may be effected by excision of the metatarso-phalangeal articulation rather than by the amputation of the member. With regard to the removal of the toe and its metatarsal bone, I must refer to p. 110, Vol. I. Whenever it is practicable, the proximal end of the bone should be saved, in order that the insertion of the tendon of the peroneus longus may be preserved.

AMPUTATION IN JOINT-DISEASES.

In those cases in which the excision of the diseased joint is not advisable, in consequence of the acute character of the articular disease, the existence not only of considerable suppuration but of great local and constitutional irritation, or the peculiar nature of the joint affected, amputation may be the sole resource left to the Surgeon. It is especially in articular disease of the fingers and toes, of the tarsus, carpus, ankle, and knee, that this operation is required; and though it is much less frequently practised now than formerly, yet the cases of destructive disease of joints requiring amputation are common in operative surgery, and will doubtless continue to be so. The Surgeon, however, must be careful, whilst he avoids continuing to make ineffectual attempts to save the limb at the great hazard of the patient's life, not to amputate until it is clear that all other means have failed; the patient continuing to lose ground so that a further perseverance in local and constitutional treatment would probably end in his death, excision not being practicable. So far from amputation being an opprobrium to surgery in such cases as these, I look upon it as one of the greatest triumphs of our art, that by a simple and easy operation, which removes the useless limb, the life of the patient may be saved, and his health speedily restored.

In amputating in cases of chronic joint-disease, in which the limb has been the seat of prolonged suppuration, it will be found, just as in many cases of secondary amputation after injuries, that the condition of the muscles of the limb is peculiar. Instead of, as in cases of primary amputation, being dark in colour and retracting forcibly and unequally when cut across, they will be found to be pale, soft, flabby, and retracting but little, if at all; resembling in this respect the muscles in a dead body. In consequence of this alteration in their structure and physiological properties, the flaps need not be cut so long in amputation for chronic joint-disease as in cases of primary amputation.

Circumstances influencing Mortality.—The mortality after amputation for joint diseases is especially influenced by three conditions: viz., the Seat of the Operation, the Acute or Chronic Character of the Disease, and the Constitutional Condition of the Patient.

The influence of the *seat of operation* has already been discussed at p. 83, Vol. I.

The *duration of the disease* exercises a most important influence, especially in the larger joints—more particularly the knee. As a general rule, it may be stated that, the more acute the suppurative destruction of a joint, especially in septic arthritis, the less successful is the amputation of the limb likely to be; pyæmia being especially apt to supervene. (See p. 86, Vol. I.)

In very acute cases, the Surgeon ought to evacuate the pus by means of free incisions, and endeavour to postpone amputation until the active suppurative stage has passed, and the affection has subsided into a chronic form. In chronic cases, the success of amputation is very great. It commonly happens that a patient who has been racked with pain, and been wasting in body for weeks before the local source of irritation was removed, sleeps soundly the night after the operation, and rapidly gains flesh and strength.

In determining upon the advisability of resecting a diseased joint or of amputating the limb, the Surgeon must be guided not only by the amount of disease in the articulation, but by the *constitutional condition* of the patient. In amputation the chief dangers are immediate—from shock, or secondary hæmorrhage. In excision the shock is not so severe, in consequence of the incision being farther from the trunk, and through comparatively superficial and unimportant parts; no large blood-vessels, nerves, or even muscles are divided, and there is no danger of secondary hæmorrhage. The dangers are chiefly remote; prolonged suppuration may follow, and the discharge of pus be abundant; the patient may consequently not have sufficient constitutional power to carry him through. So far as erysipelas and pyæmia are concerned, the danger is probably the same in both operations. In addition to this, it must be borne in mind that a patient, who would not agree to part with a limb, will often consent to have a joint or bone excised.

As phthisis not unfrequently co-exists with the advanced forms of strumous joints, the question of amputation under these circumstances becomes one of very considerable importance. If the phthisis be rapidly progressing, and there be a strong hereditary tendency to the disease, or if it have advanced to the formation of cavities, it will be useless to operate. If, however, the phthisis be but slight and incipient, and the progress of the disease be apparently due to local irritation of and discharge from the joint, to the confinement to bed that this necessitates, and to the general impairment of health that ensues, amputation may be advantageously practised; and I have performed it in many such cases to the manifest advantage of the patient.

CHAPTER L.

DISEASES OF THE SPINE.

SPINA BIFIDA.

Spina Bifida is a congenital malformation of the vertebræ in which there is an incomplete development of a certain number of the neural arches. Through the cleft thus left the contents of the spinal canal protrude, forming a tumour of variable size projecting in the middle line of the back. In extremely rare cases a cleft condition of the bodies has been met with, the tumour then projecting forwards into the thorax, pelvis, or abdomen. Such cases are merely pathological curiosities, and cannot be recognized during life. Our knowledge of the pathology and treatment of spina bifida has been greatly increased by the report published in 1885 by a Committee of the Clinical Society of London. It is by no means an uncommon malformation, for in 1882, 647 deaths occurred in consequence of it in England alone.

Symptoms.—The tumour in spina bifida is usually oval, its long diameter corresponding to the axis of the spine. It is most often sessile, but occasionally, when the cleft implicates only a few neural arches, it is pedunculated. In size it commonly varies from that of a walnut to that of an orange, but in rare cases it may equal or even exceed that of a fœtal head. Very frequently the tumour presents a longitudinal furrow, with a depression indicating the point at which the protruded cord is in contact with the sac. In some cases it is lobulated, having an imperfect septum stretching across it. In a few recorded cases more than one tumour has been present. The skin covering it is in rare cases normal throughout ; but far more commonly the natural integument surrounds the base only, the central parts of the tumour being covered by a thin glistening bluish-white membrane, presenting a certain degree of translucency. The central part usually becomes congested or inflamed from friction of the clothes and the irritation of urine, and as the tumour increases ulceration commonly takes place, which may end in perforation of the sac, which is almost inevitably followed by septic spinal meningitis and death. On examining the tumour it will be found to be tense though elastic when the child is held in the upright position, and to diminish when the child is laid flat on its face. It becomes more tense during forced expiration, as during crying, and less so during inspiration. Fluctuation is usually very evident, and in some cases the bulk of the tumour may be distinctly lessened by steady pressure, while at the same time increased tension may be recognized at the anterior fontanelle, thus demonstrating the connection of the sac with the subarachnoid space. Manipulation is not usually painful unless the skin is ulcerated.

Spina bifida may be met with in any portion of the vertebral column ; but by far the most frequent situation is in the lumbo-sacral region, which is the part of the spinal canal which closes last in fœtal life. Over 50 per cent. of all cases are met with in this part. Next in frequency stands the sacral region, with about 17 per cent. The remaining 33 per cent. are scattered about equally over the other portions of the spinal column.

Spina bifida is not uncommonly associated with other deformities, especially club-foot, talipes calcaneus being a common form. Hydrocephalus is also a frequent complication, and paralysis of the parts below the tumour is often met with. In 245 cases collected by the Committee of the Clinical Society, paralysis was recorded as being present in 53, talipes in 42, and hydrocephalus in 30. The malformation is slightly more frequent in females than in males.

Pathological Anatomy.—The tumour in spina bifida is described as being composed of a sac with its coverings and contents. The sac consists of the membranes of the cord protruding through a gap left by the want of union of some of the neural arches ; the coverings are the integuments of the back and the contents are cerebro-spinal fluid in all cases and in a large proportion a portion of the cord and the nerves proceeding from it. The cerebro-spinal fluid is clear and limpid in appearance, and of a specific gravity of from 1003 to 1006. It contains merely a trace of albumen, a considerable amount of chloride of sodium and a trace of sugar. In some forms the sac, its coverings and its nervous contents are quite distinct; but more commonly the integuments, the protruded membranes and the projecting portion of the cord are blended together at the most prominent part of the tumour.

There are three chief forms of spina bifida.

1. **Spinal Meningocele.**—In this form the membranes only are protruded, the cord and nerves retaining their normal position. Of the 125 cases examined by the Committee of the Clinical Society, 10 were of this variety. The tumour is commonly pedunculated, and escapes by a small cleft left by the want of union of one or two neural arches at the most. It has even been known to protrude between two normal neural arches. The skin covering it may be normal, but more commonly it is scar-like in the central part. Simple meningocele may occur at any part of the spinal column. It may protrude from the natural cleft at the lower end of the sacrum, forming one variety of the so-called congenital sacral tumours. Patients affected with this form may live to adult life, the tumour ceasing to increase at a comparatively early period, and possibly undergoing spontaneous cure, but this fortunate result is exceptional. In the museum of University College is a specimen obtained from a woman aged 32, who died from other causes. The tumour is covered by healthy skin and a dense fascia. It is composed of three sacs, separated from one another by membranous septa, and only one of these, and that the smallest, communicates with the spinal canal.

2. **Meningo-myelocele.**—In this form a portion of the cord and the nerves coming from it are protruded with the membranes. Seventy-six of the 125 cases examined by the Committee were of this kind. The tumour is very commonly sessile, and corresponds to a cleft formed by the want of union of several neural arches. The wall of the protrusion, except in its central part, will be found to be composed of normal skin, dura mater, and arachnoid, each of which can be recognized. The central part is scar-like in appearance, and composed of a layer of epithelium covering a thin layer of fibrous tissue, representing the cutis and the protruded membranes with the inner surface of which the projecting part of the cord is incorporated. The sac is distended with cerebro-spinal fluid, and the nerves arising from the

protruded part of the cord cross the cavity to reach their respective foramina. The nervous tissue of the cord is usually much thinned and spread out at the point at which it is adherent to the sac, so as sometimes to be scarcely recognizable except by the nerves springing from it. In most cases a shallow depression marks externally the point at which the cord is adherent to the sac.

3. **Syringo-myelocele.**—In this form the central canal of the cord is dilated, and the interior of the sac formed by the protruded membranes is lined by a thin layer of nervous tissue, between which and the sac lie the nerves arising from the part of the cord implicated. This variety is very rare. The Committee of the Clinical Society met with only two unequivocal examples.

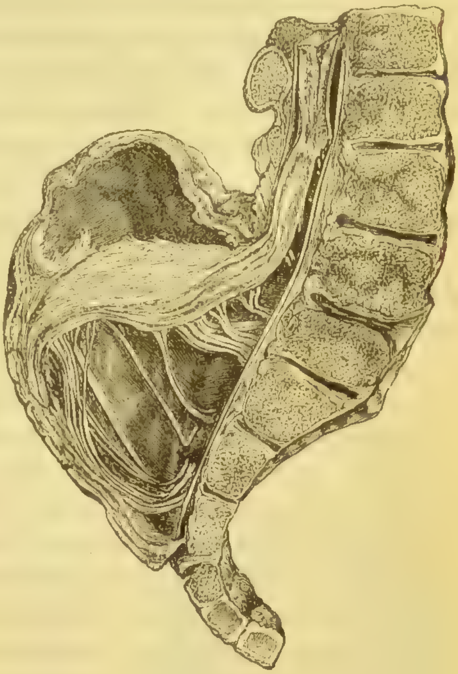


Fig. 573.—Vertical section, through a meningo-myelocele.

Under the name of **Spina Bifida Occulta** a few cases have been described by Ornstein, Virchow, Fischer, Bland Sutton, and others in which the essential conditions of a meningo-myelocele are present without the protrusion of any tumour. That is to say the neural arches are cleft and in the gap the skin, membranes and cord are blended together. There is a depression corresponding to the deficient spine, and from this has sprung in all recorded cases a tuft of hair sometimes of extraordinary length. In some of the cases the whole lumbar region was covered with thick hair. This form of the disease has been accompanied in at least three of the recorded cases by ulceration and disease of the bones of the foot, resembling the so-called "perforating ulcer" (p. 17), and a case of the same kind was lately in University College Hospital. In some there has been a slight degree of club-foot.

In another rare form of spina bifida occurring in the sacral region, the tumour is composed of a small protrusion of the membranes covered by a thick layer of somewhat dense fat, completely concealing the nature of the disease. I have known of a case in which an attempt was made to remove the tumour, under the impression that it was a fatty outgrowth. The small protrusion of the membranes was only discovered when it was wounded towards the end of the operation. The patient died of septic spinal meningitis.

The occurrence of spina bifida has been attributed to an excessive secretion of cerebro-spinal fluid or to dropsy of the central canal, causing a protrusion of the membranes, and thus preventing the union of the neural arches. Possibly in the case of a simple meningocele the former may be the true explanation. In the meningo-myelocele, however, as pointed out by R. W. Parker and Shattock, this theory will not explain the displacement backwards of the cord and its fusion with the thin central part of the sac. In these cases it is apparently due to a primary arrest of development of the neural arches occurring at a very early period immediately after the separation of the part of the epiblast forming the spinal cord from that forming the epithelial covering of the body. Normally this should be followed by the development of two processes of the mesoblast, one from each side, which insinuating themselves between the epithelium and the primitive spinal cord, subsequently develop into the neural arches and membranes of the cord. An arrest of the development of these processes explains the pathological appearances in this form of spina bifida.

The **Diagnosis** of the different forms is in many cases impossible. When the tumour is pedunculated and covered by healthy skin, it is probably a simple meningocele. When it is sessile, covered in great part by thin, almost translucent, scar-like tissue, and presents a furrow or depression in the middle line, it is almost certainly a meningo-myelocele. The syringo-myelocele cannot be recognized with certainty.

The **Prognosis** is always bad. Spontaneous cure does, however, occasionally take place, 14 such cases having been collected by the Committee of the Clinical Society ; but these form but a small percentage of the whole. A simple meningocele is not incompatible with long life if it is pedunculated and covered with healthy skin. The meningo-myelocele is commonly fatal if not relieved by treatment, death usually occurring from convulsions, or from ulceration and perforation of the sac and septic meningitis. The syringo-myelocele is probably inevitably fatal. The larger the tumour in all forms the worse is the prognosis. It may be stated as a general rule that spina bifida is more dangerous the higher it is seated on the spine. Paralysis of the parts below the deformity is a hopeless complication.

Treatment.—In cases in which the infant is otherwise healthy, the tumour small, pedunculated, and covered by healthy skin, and in which it shows little or no tendency to increase, we shall probably best consult the welfare of the child by abstaining from all operative interference, and merely protecting the tumour by a piece of leather or cotton-wool. On the other hand, if the tumour is increasing in size, there is little hope of recovery without operative interference. According to the Committee of the Clinical Society, the best results are to be hoped for in children who have reached the age of two months, in whom there is no paralysis or hydrocephalus and when the sac is covered by healthy skin. Distinct evidence of the cord being in the sac, as shown by umbilication and a longitudinal furrow ; a very thin membranous or ulcerated sac ; previous rupture ; the occurrence of a distinct impulse between the sac and the anterior fontanelle ; a sac, the contents of which are easily returned into the spinal canal, and a very early age of the patient are all unfavourable conditions, yet do not necessarily contra-indicate operation if the general health is good. If the child is wasted, hydrocephalic or paralysed below the tumour, any surgical interference will probably only hasten the inevitable death.

Six methods of treatment have been adopted for the cure of spina bifida : puncture or aspiration followed by pressure ; ligature of the neck of the sac ; excision of the sac ; antiseptic drainage ; injection of tincture of iodine and injection of Morton's iodo-glycerine solution.

Puncture is not a very successful mode of treatment, being very commonly fatal by meningitis. Of 46 cases treated in this way, collected by the Committee of the Clinical Society, 30 died. The case from which the accompanying drawing is taken, was, however, cured by this treatment. It was that of a young girl. At birth the tumour was small, but it gradually increased in size, until when the child was thirteen it had attained the following dimensions:—Circumference at base 25 inches; length over greatest convexity 19 inches; breadth $14\frac{1}{2}$ inches. The tumour occupied the lumbo-sacral, and stretched over both gluteal regions. It was tense and translucent; the skin reddened, very thin, and becoming darkly congested at the more prominent part, evidently in imminent danger of bursting. Health excellent; development good. I tapped the tumour and drew off 101 ounces of cerebro-spinal fluid. When emptied, an aperture $1\frac{1}{2}$ inch long, and three-quarters of an inch broad, could be felt at the lower lumbar and upper sacral regions to the left of the mesial line. The parts were well padded with cotton-wool and supported by an elastic bandage. No ill effects followed the tapping. This was repeated nine times in eighteen weeks, 985 ounces in all of clear cerebro-spinal fluid being drawn off; the largest tapping amounted to 120 ounces, the smallest to 93. After each tapping, methodical compression was employed. The ninth tapping was followed by signs of irritation in the lining membrane of the tumour, which became greatly thickened, evidently by inflammatory exudation. The temperature rose to 103° F., and symptoms of spinal meningitis with a tendency to opisthotonos and convulsive movements came on, but passed off. The sac gave way and a considerable quantity of pus was discharged, after which all the symptoms were relieved. The cavity closed by granulation, the skin covering it being thickened and corrugated; the patient soon completely recovered, and is now, fifteen years after the operation, strong, healthy, and active.

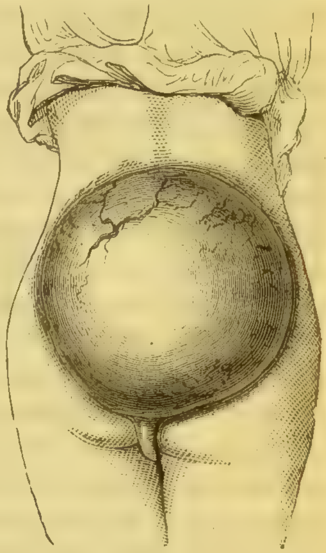


Fig. 574.—Large Spinal Bifida, cured by tapping and pressure.

By the combination of pressure and occasional tapping by means of a trochar, Sir A. Cooper succeeded in curing one case. If it be thought desirable to apply pressure it may be done by means of a compress and bandage; or, what is better, an air-pad, similar to those used for umbilical hernia, kept in place by an india-rubber band. Any punctures made in tapping must be carefully closed with collodion.

Removal of the tumour by **ligature** or **gradual strangulation** is evidently justifiable only in cases of simple meningocele, and even in these it has not been attended by any great degree of success. Wilson in one case removed the tumour by the gradual pressure of a clamp applied to its base, and keeping the parts in close apposition by means of this instrument, so as to prevent the entrance of air, and the consequent occurrence of septic meningitis. In this case the tumour was as large as an orange, and not pedunculated. If it have a narrow base, the prospect of cure by this means will be better, but before attempting any operation of this kind the tumour should be illuminated by strong transmitted light in order to ascertain the presence or absence of the spinal cord or nerves.

Excision is open to the same objections as ligature. In fact, all plans of treatment, by which the tumour is opened, and the air allowed to enter it, are fraught with danger from inflammation of the meninges of the cord, and convulsions, and, as a general rule, are to be condemned. It is true that recovery has taken place after antiseptic drainage, and after removal of the sac in simple meningocele with antiseptic precautions, but the amount of success has not been sufficient to justify a repetition of the operation.

The Committee of the Clinical Society, after a most exhaustive inquiry, report strongly in favour of **injection of the sac** as the most efficient mode of treatment. They record 26 cases in which aqueous or spirituous solutions of iodine were used with 20 recoveries, 5 deaths, and 1 failure. These were probably carefully selected, and show a higher rate of success than could be expected if the treatment was more widely adopted. The simple iodine solutions have been almost completely abandoned since 1876 in favour of a special preparation introduced by Morton of Glasgow. It is composed of iodine gr. x., iodide of potassium gr. xxx., and glycerine ℥j. The advantage of the glycerine solution seems to be that it diffuses extremely slowly, and consequently if the patient be kept recumbent and partially erect, it has little tendency to extend into the spinal canal. The quantity injected should be from half a drachm to a drachm and a half. It is best done by means of a screw syringe fitted with a fine platinum needle. If the sac be tense, the needle may first be introduced and a small quantity of the fluid drawn off, but in most cases the iodo-glycerine solution may be directly injected. The puncture, which should be made through the thick part of the coverings at the lateral aspect of the tumour, must be carefully closed with lint and collodion. Should the sac continue to leak at the puncture, suppuration and meningitis are very likely to occur. After the injection a flannel bandage may be applied over some cotton-wool covering the tumour, and the child must be kept as far as possible in the recumbent position. The Committee have collected 71 cases treated by this method, of which 35 recovered, 27 died, 5 were unrelieved, and 4 were improved. Since the publication of Morton's paper in 1877 his treatment has been very widely adopted, perhaps without sufficient care in the selection of proper cases. Amongst the 71 cases no less than 22 were suffering from paralysis, and only 17 are stated to have been free from complications. Moreover, in many of the fatal cases, death was not due directly to the treatment. Morton himself in 1885 stated that he was able to refer to 50 cases, 41 of which might be regarded as successful. It is evident, therefore, that when we consider the dangers accompanying other modes of treatment and the hopelessness of the disease in most cases if left to itself, the amount of success obtained is quite sufficient to justify the injection of the iodo-glycerine solution in all cases not evidently unsuited for any operative interference.

CARIES OF THE SPINE.—ANGULAR CURVATURE—POTT'S DISEASE.

This disease, which consists, in its full development, of destruction of the bodies of some of the vertebræ, with disintegration of the corresponding intervertebral fibro-cartilages, most commonly occurs in young children, sometimes even during the first year of life. It is, however, met with at later periods, not uncommonly commencing at puberty, and sometimes much later still. I have seen it set in after fifty.

Pathology.—Angular curvature of the spine, or "Pott's disease," as it is commonly called after Percival Pott, the celebrated Surgeon to St. Bartholomew's Hospital, who first accurately described it in 1779, is said to originate in; 1, the bodies of the vertebræ; and, 2, the invertebral fibro-cartilages. The relative frequency with which the disease commences in these two structures has been the subject of considerable difference of opinion, some Surgeons maintaining that in the great majority of cases the intervertebral cartilage is the starting point of the destructive process, and others that it is rarely if ever primarily affected. The cause of this uncertainty seems to be that by the time the opportunity arrives for examining the diseased structures the morbid changes are so advanced that it is impossible to say where they commenced. In the vast majority, if not in all, of the specimens obtained at an early stage of the disease, from patients dying of some accidental complication, there is no doubt that the starting point of the morbid change is the bone. While, therefore, we are not in a position to deny that the disease may originate in the intervertebral discs, this mode of origin is, to say the least, rare.

The pathological processes occurring in caries of the vertebræ differ in no material respect from those already described (p. 285) as taking place in cancellous bone elsewhere. When the disease commences in the bone, the vessels of the medullary tissue are first dilated in the affected area (inflammatory congestion); the tissue next becomes infiltrated with small round cells before which the normal structures disappear. Thus the cancellous spaces become filled with new cells, amongst which capillary loops may penetrate (granulation-tissue). The bony trabeculæ enclosing the spaces are first thinned and finally completely absorbed by the advancing cell-growth; thus a portion of the cancellous tissue of the body of a vertebra may be destroyed, its place being occupied by granulation-tissue. These changes form an essential part of all varieties of caries; the fate of the granulation-tissue, however, differs in different cases, the following being the chief modifications of the subsequent processes:—

1. The granulation-tissue replacing the cancellous bone may be absorbed apparently as the result of the pressure exerted upon it by the weight of the trunk. Thus a steadily progressive destruction of bone may take place without there being any extensive accumulation of granulation-tissue, and without the formation of pus. This *dry caries*, as it is termed, is very common in the spine, being the process that takes place in those numerous cases of angular curvature in which the patient escapes without the formation of an abscess. Its progress is sometimes very rapid, leading to great deformity in a very short time.

2. Instead of being absorbed the granulation-tissue may undergo fatty degeneration, and a slow process of suppuration, with the formation of curdy pus, may take place. The pus gradually accumulates, forming a chronic abscess, which slowly forces its way to the surface, following the lines of least resistance.

3. The granulation-tissue may caseate early, before the bony trabeculæ are completely absorbed. The unabsorbed bone then perishes, forming a sequestrum. This *necrotic caries* is very common in the spine.

3. The granulation-tissue may calcify. This is not uncommon in the spine. It is said to be one mode of cure, especially when the disease is tubercular and the area affected very limited, the small calcified nodule lying harmlessly embedded in the surrounding bone. Small necrosed fragments of cancellous bone with its spaces filled with calcified inflammatory products, are sometimes

met with in the discharge from abscesses connected with angular curvature of the spine.

5. Lastly, if all sources of irritation are removed, the rarefying osteitis may cease to extend, and the granulation-tissue become developed into bone, thus effecting a cure of the disease. The points at which caries most commonly commences, are first, in the growing tissue between the cartilaginous discs forming the upper and lower parts of the body of the vertebra; secondly, beneath the periosteum in front; and, thirdly, in the central parts of the bone.

The destructive process extends not only into the bone, but also, usually at an early period, into the intervertebral fibro-cartilages. As the disease commences most commonly between the epiphyseal cartilage and the bone, the thin layer of cartilage is soon destroyed by the same processes as are observed in the destruction of articular cartilage in chronic inflammations of joints (p. 347). The granulation-tissue then penetrates into the intervertebral disc, which is destroyed, after which the morbid process extends into the body of the next vertebra.

The **causes** of the disease when it commences in the bone are, first, injury in an unhealthy subject, and, secondly, deposit of tubercle. The fact that the most common starting point is the soft growing tissue between the bone and the epiphyseal layer of cartilage, and that it is usually situated at the anterior part which would be most powerfully compressed during forcible flexion of the spine, is strong evidence that the primary cause of the disease is frequently *an injury.* In some cases there is a clear history of injury, such as a fall, but as the disease is most common in young children and commences insidiously, the history cannot as a rule be implicitly relied upon. That the disease is in most cases due to the *tubercle* is now universally recognised. The evidence in proof of this is the following: First the disease frequently commences in many independent centres, often in the bodies of different vertebræ, and in situations, such as the front of a body or in its central parts, which are little exposed to injury. Secondly in patients dying of advanced caries affecting one part of the spine separate centres of disease in an earlier stage are frequently found in other vertebræ. The granulation-tissue removed from these has been shown to contain non-vascular, caseating nodules presenting the characteristic anatomical structure of the tubercle-nodule (Vol. I., p. 1082), and further the presence of the tubercle-bacillus has been demonstrated in many cases. Thirdly, the early caseation of the inflammatory products and the chronic suppuration correspond with the course followed in tubercular inflammations elsewhere. And, lastly, a considerable proportion of patients dying of caries of the spine are found to be infected with general tuberculosis.

It is not, however, proved that all cases are tubercular, especially those distinctly due to injury and recovering without suppuration. It seems not improbable that occasionally as the result of forcible flexion of the spine bruising of the growing tissue between an epiphysis and the body may take place. If the injured part could be put at perfect rest, recovery would follow without further trouble; but if the patient continues to move about, bearing the whole weight of the head and shoulders upon the injured vertebra, chronic rarifying osteitis may be set up as a result of mechanical irritation, ending in more or less extensive destruction of the bodies of the vertebræ.

In whatever way the disease commences the most common cause of its persistence is the mechanical irritation of the diseased surfaces by the friction of movement, aggravated by the weight of the parts of the body above the affected vertebræ. In other cases the presence of sequestra, which cannot find a way out, may keep up the disease indefinitely. It seems probable that caries originally tubercular may become simple in character as the disease progresses. The original tubercular centre may completely caseate and soften, exciting inflammation in the tissue around it, and be thus eliminated, the subsequent progress of the disease being due to the mechanical causes above mentioned. In other cases the tubercular process may infect the surrounding parts and maintain its characteristics to the end.

I know of no exact description of any *primary pathological changes taking place in the intervertebral discs.* As before stated, we are not in a position to deny that disease may originate in these structures, but by the time the case comes to be examined after death the fibro-cartilage has disappeared, and we find only the signs of rarefying osteitis in the vertebræ on each side. Luschka states that there is a synovial cavity in each disc, and that the lobes of the pulp correspond to the villi of a synovial membrane. If this be true it would be in this structure that any primary inflammation or deposit of tubercle would take place, and not in the dense fibrous and fibro-cartilaginous layers forming the outer zones of the disc.

The nature of the pathological changes being borne in mind, the coarser morbid appearances are easily understood.

Dry caries, or caries without suppuration, forms the simplest variety of the disease. It affects usually a limited portion of the spine, often only two vertebræ with the intervening intervertebral disc. The destruction of the bodies of the vertebræ in these cases often takes place somewhat rapidly, and at the same time the osseous tissue is softened by extension of the rarefying osteitis for some distance from the centre of the disease. In consequence of this the weight of the body above the diseased vertebræ, causes a bending forwards of that portion of the column, and a corresponding projection backwards of the spinous processes. A vertical section made through a spine thus affected shows the anterior common ligament thickened and swollen. The bodies of the affected vertebræ are softened and partly destroyed, the destruction being almost invariably more extensive anteriorly, as this part is exposed to the greater pressure when the spine is bent forwards. The intervertebral cartilage between the two vertebræ has more or less completely disappeared ; if any remains it will be at the posterior part. The opposed surfaces of the vertebræ are covered by granulation-tissue, and are sometimes mutually adapted to each other as the result of friction. In the cancellous spaces of the bone on each side the normal medulla has disappeared, and its place is taken by the same tissue. The periosteum covering the remaining portion of the vertebræ and frequently also that of the vertebræ above and below is affected by osteoplastic inflammation, irregular spiculated nodules of new bone being formed beneath it. The spines, the transverse and the articular processes being unaffected, there is no dislocation, and consequently the spinal canal is but little if at all narrowed. Should the disease cease at this stage, as it frequently does, the granulation-tissue of the opposed surfaces coalesces, and subsequently becomes developed into bone, and the angle formed by the bending of the spine is filled up by a buttress of bone formed beneath the periosteum, and thus the spine, although retaining its deformed position, may become as strong as before the disease. (Fig. 575.)

In other cases of caries of the spine the disease is more extensive, commencing from many centres, often situated in different vertebræ and unconnected with each other. These centres are situated most commonly in the immediate neighbourhood of an intervertebral disc, but are not uncommon on the surface of the body beneath the periosteum, and are sometimes deeply in its substance. A macerated specimen shows the bone to be eaten out into irregular hollows, around which the cancellous tissue is more porous than natural. In a fresh specimen these hollows are filled with caseous granulation-tissue. When the disease commences near an intervertebral disc, this is soon destroyed, and the contiguous surface of the next vertebra becomes implicated (Fig. 576). The friction of the diseased surfaces against each other then aggravates the process, and leads to more rapid destruction at the parts where they are in contact. This form beginning in numerous centres is evidently tubercular, and most frequently terminates in suppuration.

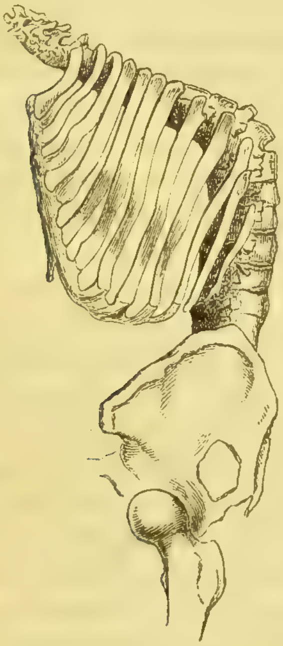


Fig. 575.—Angular Curvature of the Dorsal Spine from Caries and Ankylosis.

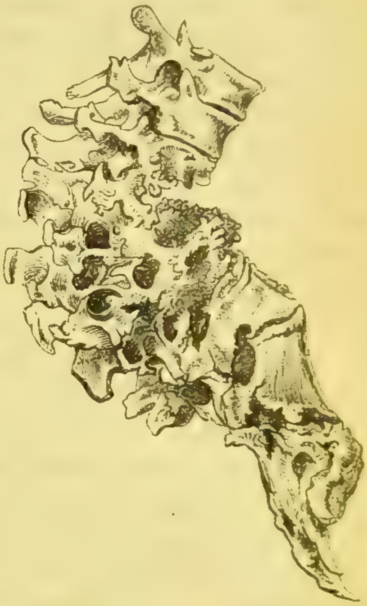


Fig. 576.—Caries of Bodies of Lumbar Vertebræ : no attempt at Ankylosis.

In some cases instead of the bone being more spongy than natural round the excavations, it may be seen in the macerated specimen that the osteitis has assumed an osteoplastic form, the cancellous tissue being denser than natural, and its trabeculæ thickened, just as a zone of dense bone is often found around a chronic abscess in the cancellous ends of the long bones.

When the disease leads to suppuration, the pus frequently raises the anterior common ligament from the vertebræ for some distance. This is more likely to happen when the resulting chronic abscess has opened externally and become septic. Rapid destruction of the intervertebral discs with which the pus comes in contact then frequently takes place. It is not uncommon to find the vertebræ for some distance above and below the centre of disease bare in front, and looking as if macerated, while the cartilages between them have more or less completely disappeared.

The chronic abscesses forming in connection with caries of the spine are directed to the lateral aspect of the bodies of the vertebræ by the great thickness of the anterior common ligament. As the pus accumulates the abscess makes its way, as in the case of chronic abscesses generally, in the direction of least resistance, usually following the course of a vessel or burrowing beneath the fasciæ covering muscles. Thus in disease of the dorsal vertebræ, the abscess follows the intercostal artery and passes between the ribs with the posterior branch, appearing under the skin of the back as a "dorsal abscess." In the lumbar region the abscess may in the same way follow a lumbar artery and form a "lumbar abscess," or enter the sheath of the psoas muscle and form a "psoas abscess," pointing below Poupart's ligament.

When the caries is complicated by necrosis, the sequestra are frequently so entangled in the excavated cavity in the body of the vertebræ, covered in in front by the thickened anterior ligament, that it is impossible for them to make their way to the surface, and thus even if the disease ceases to extend, suppuration may be indefinitely prolonged till it causes the death of the patient.

The angular projection backwards of the diseased part of the spine, corresponding in extent to the amount of destruction of the vertebræ, forms usually the most marked feature of the disease (Figs. 577—579). The mechanism of this is easily understood by reference to the pathology of the affection. The bodies (one or more) of the vertebræ, being softened or partly destroyed, at last give way under the weight of the upper part of the body; the upper part bends forwards, and the spine projects posteriorly. At the same time that the upper part bends forwards, the lower part of the spine rarely maintains the upright position as it did in Fig. 575. In the great majority of cases there is a compensating incurvation just below the excurvated vertebra, and in this way the upper part of the body is carried erect. The angle of excurvation varies according to the number of vertebral bodies destroyed, and the extent of the

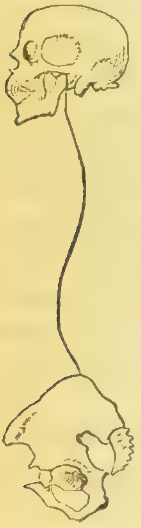


Fig. 577.—Natural Curve of Spine.

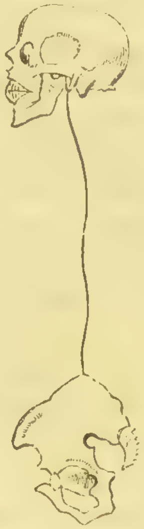


Fig. 578.—First early Change of Curve in Angular Curvature.

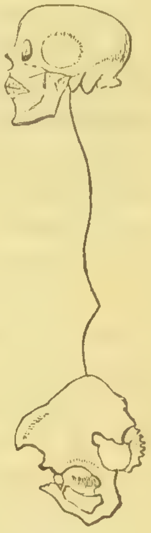


Fig. 579.—Change of Curve of Spine in Advanced Stage of Angular Curvature.

loss of substance and the part of the spine affected. In the cervical and lumbar regions the natural curve having its convexity forwards is at first straightened out, angular projection of the spines only occurring in very extreme cases. The greater the number of vertebræ affected the more obtuse will the angle be. When one vertebra is alone or chiefly diseased, three spinous processes will project to form the angle, that of the diseased vertebra being the apex. If two or three be diseased, five spinous processes usually enter into the formation of the angle of excurvation, and then the whole of this portion of the column will be displaced backwards, giving a thickened and broadened base to the excurvation in the lateral direction. In the dorsal region, if a single vertebra is diseased, the projection is usually very marked and sharp as the bending forward of the vertebra turns the long oblique spine almost directly backwards, forming a sharp prominence. In the lumbar region, where the spines are short and point directly backwards, the projection is more rounded.

It very rarely happens that the cord is pressed upon by the displaced bones, though it may be affected secondarily by disease of the membranes (see Slow Compression of the Cord, p. 438).

The **most common seat** of caries of the spine is the lower dorsal or the junction of the dorsal and lumbar regions. It is not uncommon in the middle dorsal, and may occur at any part. R. W. Parker states that in 149 cases, the disease was in the cervical region in 9, in the dorsal in 82, in the dorso-lumbar in 21, and in the lumbar or lumbo-sacral in 37.

Symptoms.—Angular curvature, or Pott's disease of the spine, commonly begins, especially in children, in a very insidious manner. It occurs usually in strumous children, and is generally referred to a fall or blow on the back. The symptom that most often first attracts attention is the child's attitude, which is altered and very characteristic. The body is held stiffly straight and upright; it is neither bent nor turned to one side when the child moves, but the spine is moved as a whole and in a rigidly fixed manner. The shoulders are raised, the chin is thrown up, and the toes are slightly turned in. The child walks with great caution, and very stiffly.

One of the earliest symptoms complained of is often an ill-defined superficial pain, extending round the trunk, more severe, perhaps, on one side than on the other, and occasionally referred to the stomach. After a time the child becomes unable to stand upright unsupported, has a tendency to lean the body forwards, or to support it by resting the hands on the knees, or by seizing hold of anything that will serve as a temporary support, such as a chair or table. If asked to pick up an object from the floor, it will go carefully down upon its hands and knees instead of stooping in the natural way. It will be found also that the child experiences great difficulty in raising itself without assistance from the horizontal into the sitting position, or in turning sideways in bed without the use of its arms. On examination, one or two of the spines, usually about the middle of the back, will be found to be a little more prominent than the rest; and on pressing or tapping upon them, pain will be complained of. The child becomes stunted in its growth; and, if the disease be not arrested by proper treatment, will continue more or less hump- or round-backed for life. In other cases the disease will run on to the formation of abscess, as will immediately be described, tubercular disease occurring elsewhere, and death eventually resulting.

In *adults*, the danger and the symptoms vary according to the seat of the affection. It is most dangerous, often indeed rapidly fatal, when the cervical vertebræ are implicated; for, as the bodies of these are shallow, caries readily penetrates to the spinal canal, and the cord or its membranes may thus be implicated. When the dorsal or lumbar vertebræ become diseased, the affection is not so immediately serious to the life, as it may be to the figure of the patient. In adults it often commences with obscure flying pain in the loins or back, resembling rheumatism, shooting round the body or down the thighs. On examining the spine, which feels weak to the patient, and which, as in the child, is incapable of supporting him or of enabling him to raise or turn himself without assistance, tenderness on pressure or on tapping will be experienced at one point, and he will wince when a sponge wrung out of hot water is applied to this part of the spine; although there may be no appearance of excurvation, the skin covering it is often hyperæsthetic. After a time, however, the spinous process of one or more vertebræ will be found to project distinctly beyond the general line of the column. This part becomes the seat of constant aching pain, increased by movement or by pressing upon the head or shoulders. It must, however, be remembered that caries of the bodies of the vertebræ may take place to a considerable extent with little or no angular curvature. In these cases all the ordinary symptoms of caries of the spine will be found, except the excurvation. It will be observed that the spine has lost its natural free mobility and flexibility, moving fixedly, stiffly, and as a whole, when the patient leans forwards or sideways. If asked to stoop down the patient will bend the body forwards rigidly without bending the spine. He cannot put on or lace up his boots. When laid flat on his back, he cannot raise himself into a sitting position without the aid of his hands or elbows, and he cannot turn sharply and suddenly over upon his face, but struggles with outstretched arms in vain attempts to do so. Occasionally the incipient curvature, when it occurs, assumes more of a lateral than of an angular direction; and in one fatal case I have seen the spine actually bent backwards, so as to be incurvated at the seat of the disease. In some cases, the true angular excurvation dependent on caries of the bodies of the vertebræ may be associated with the ordinary lateral curve of debility. The lower limbs become weak, and the patient walks with a peculiar shuffling tottering gait, the legs being outspread, and the feet turned out. The weakness of the limbs is especially marked in going upstairs, and may be tested by directing the patient to stand unsupported on one leg, and raise the other so as to place the foot upon the seat of a chair, which he will probably be unable to do. The deformity of the spine may slowly increase; the patient may become unable to stand; and paralysis of the muscles of the lower extremity may come on.

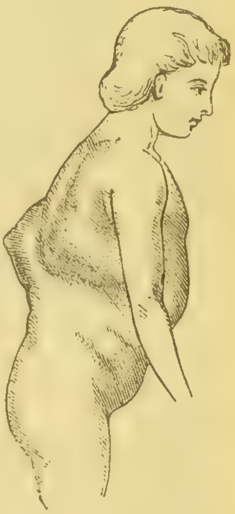


Fig. 580.—Attitude of Child in Angular Curvature in Advanced Stage.

Pleuritic Attacks of a localized character dependent on extension of the inflammation to the contiguous pleuræ have been observed in rare cases of caries affecting the dorsal spine.

Abscess commonly makes its appearance as the disease progresses; and in some cases it occurs before any of the other signs except pain and weakness of the spine, and certainly before any deformity. When the abscess appears, as Stanley has observed, the pain consequent on irritation of the spinal cord and nerves is often lessened for a time.

It must not be supposed that abscess necessarily follows in all cases. In children especially we often meet with great excurvation without any suppuration. In adults it is very rare to see angular curvature without the formation of an abscess. The exact causes that determine the formation of pus are not certain in all cases. In many it is undoubtedly due to the irritation caused by the friction of the diseased surfaces against each other, and proper treatment adopted early will do much to prevent it. Suppuration is also more likely to occur when the patient is poorly fed and exposed to general unhygienic surroundings.

As cases in which abscess does not form usually recover, we have but little definite knowledge as to the exact nature of the disease, whether it is tubercular or not. On the other hand, almost all, if not all, the cases in which death takes place are found to be associated with the presence of tubercle in the diseased bones. It has been assumed, therefore, that the cases of angular curvature without suppuration are due to simple inflammation, (p. 431) probably of traumatic origin, while those with suppuration are tubercular, but the evidence is not sufficient to justify an absolute statement to this effect.

In cases which recover without suppuration the diseased bodies become fused together into a single mass, across which bridges of osseous tissue are thrown out, so as to strengthen the otherwise weakened spine. This is the natural mode of cure of angular curvature of the spine, and the only way in which it can take place when once the disease has advanced to any considerable extent.

When pus forms in connection with diseased spine, the situation and course of the abscess depend mainly upon the part of the spine affected; thus, for instance, when the cervical vertebræ are diseased, the abscess will come forwards behind the pharynx, and may occasionally extend under the sterno-mastoid muscle to the side of the neck, where it opens; sometimes, though very rarely, it passes into the chest, and in other cases into the axilla.

When the disease is seated in the upper or middle dorsal spine, the abscess most commonly passes backwards between the posterior ends of the ribs, forming a *dorsal abscess.* In some cases, however, in which the middle dorsal vertebræ are diseased the abscess may extend downwards. When it takes this direction it most commonly passes under the ligamentum arcuatum internum, and thus enters the sheath of the psoas muscle and takes the course to be described immediately. In rare cases it may pass between the pillars of the diaphragm with the aorta and follow the large vessels in the subperitoneal tissue superficial to the fascia of the psoas and iliacus, forming an accumulation filling the iliac fossa and pointing above Poupart's ligament, or it may extend downwards into the pelvis and escape with the gluteal artery through the great sciatic notch, giving rise to a large abscess in the gluteal region. It is remarkable that in caries of the dorsal vertebræ the pus does not tend to encroach on the chest or the pleural cavity. When the lower dorsal or upper lumbar vertebræ are diseased the pus enters the sheath of the psoas or the substance of the muscle, thus constituting the common affection termed *Psoas Abscess.* A psoas abscess follows the course of the muscle from which it derives its name. It is firmly bound down in front by the fascia covering that muscle and the iliacus, which is usually considerably thickened and is never perforated by the pus. The psoas muscle is usually extensively destroyed. The pus is prevented from extending downwards into the pelvis by the attachment of the ilio-psoas fascia to the brim; there is nothing to limit its extension outwards over the whole surface of the iliacus, though the attachment of the fascia to the crest of the ilium prevents its passing beyond that point. Thus we find that a psoas abscess usually extends outwards, forming a large fluctuating swelling filling the iliac fossa. As the accumulation increases it passes beneath Poupart's ligament most commonly by a somewhat narrow neck situated in the line of the anterior crural nerve. It is thus at this part situated to the outer side of the femoral vessels. Fluctuation can readily be felt between the swelling on the thigh and that in the iliac fossa. There is very distinct impulse communicated to the part outside the abdomen on coughing, and this, combined with the somewhat sudden appearance of the swelling on the thigh, may make it in some respects resemble a hernia. After reaching the thigh the abscess extends downwards to the outer side of the vessels for a short distance till it meets the profunda, and following that vessel it passes under the femoral artery, which can be felt stretching across it in front. It then continues its course under the adductor longus, and forms a large cavity at the inner side of the thigh, having the gracilis stretched over it internally, the adductor magnus behind it, and the adductor longus in front. Processes frequently extend from the main cavity along the branches of the profunda. The most common of these prolongations is one winding round the neck of the femur with the branches of the internal circumflex, and passing through the interval between the adductor magnus and the quadratus femoris, becoming superficial immediately behind the trochanter major, between it and the tuberosity of the ischium. The abscess seldom extends beyond the upper part of the thigh, but it may continue its course downwards, until it reaches the popliteal space, and may even pass some distance downwards between the deep and superficial muscles of the calf following the main vessels. I have seen an abscess, which took its origin in disease of the dorsal vertebræ, opened by the side of the tendo Achillis (Fig. 92, Vol. I.). A psoas abscess when fully developed usually consists of four parts, a narrow track in the upper part of the psoas muscle, a wide expansion in the iliac fossa, a second narrow part extending under Poupart's ligament and the femoral vessels, and a large cavity on the inner side of the thigh. The difficulty of properly draining such a cavity by an opening in the thigh only is evident. In some cases the abscess may follow both psoas muscles, and project in each groin at the same time.

As in the dorsal region, the abscess may pass backwards instead of downwards, and point in the loin, forming a *lumbar abscess*. More rarely it may burrow amongst the layers of the abdominal muscles and point in front. In disease of the lower lumbar vertebræ and upper part of the sacrum the pus may get beneath the fascia covering the pyriformis, and then following the nerves, may point in the buttock beneath the gluteus maximus, or it may extend downwards to the ischio-rectal fossa. In all spinal abscesses small sequestra derived from the diseased vertebræ are not uncommonly found in the pus. In the patient from whom Fig. 580 was taken several fragments of bone thus came away from an abscess that was opened in the fore-part of the thigh. Much curdy matter is usually present, making it impossible in many cases to empty the sac by aspiration. The true source of origin of these abscesses may usually be determined by an examination of the spine, and by feeling an impulse on coughing communicated to their extreme points of presentation. In psoas abscess the attitude of the patient is often characteristic. He stands leaning a little forwards with the thigh of the affected side slightly flexed and adducted in order to relax the affected muscle. Forced extension is accompanied by pain and aching of the back. The attitude and pain may thus resemble that of disease of the hip-joint. General œdema of the limb may occasionally arise from a psoas abscess after it has reached the inner side of the thigh. In rare cases after opening, if septic inflammation follows, the abscess cavity may ulcerate into the hip-joint, causing acute and rapidly destructive arthritis.

Slow Compression of the Cord in Spinal Disease.—As before stated pressure upon the spinal cord is very rarely the direct result of displacement of the vertebræ in caries of the spine. In fact it may occur in cases in which there is no deformity, and again recovery very commonly takes place while the angular curvature remains unchanged or is even increasing. The true pathology of this complication was first pointed out by Michaud, and his observations have been fully confirmed by Charcot and others. In rare cases the pressure may be due to the formation of a chronic abscess pushing back the posterior common ligament against the cord. Such an abscess may gradually reach the surface, and rapid relief of pressure will follow, when it is opened externally. Far more commonly, however, the ligament itself is invaded by tubercular granulation-tissue, and at last perforated. The external surface of the dura mater is then affected, and a fungating button-like mass of tubercular granulation-tissue forms upon it by which the cord is compressed. The condition is described by Charcot as a "kind of external caseous pachymeningitis." The inner surface of the dura mater is not affected, and the subsequent changes in the cord are due to pressure only. The morbid process in the dura mater may extend backwards on each side, but rarely forms a complete ring. The effect of the pressure upon the cord is to set up a chronic inflammatory process in the compressed segment—chronic transverse myelitis. In the affected area, according to Charcot, the neuroglia appears transformed into a dense resisting connective tissue. Generally, the medullary cylinders of the nerve tubules disappear, leaving behind only groups of fat granules. Some of the axis-cylinders are destroyed, many persist and some even seem to be augmented in size. The grey matter of the cord is affected last, and only in extreme cases.

As soon as the pressure becomes sufficiently severe to interfere with the passage of nervous impulses through the affected segment, secondary degenerative changes take place, above in the sensory paths and below in the motor.

The effects of the chronic thickening of the dura mater, are, of course, not limited to the cord. The nerves passing through the diseased membrane also suffer, and many of the most characteristic symptoms are due to this. The nerves may also be pressed upon in some cases in their foramina by the falling together of two contiguous vertebræ as their bodies are destroyed.

Symptoms.—The symptoms must be divided into those due to pressure upon the cord itself and those arising from pressure on the roots of the nerves.

The earliest symptom of pressure on the cord is motor weakness in the muscles connected with the compressed segment and with the cord below it. As a rule there are no sensory phenomena at first, but occasionally pricking, formication or a sensation of constriction round the body may be present. As the pressure augments, the motor weakness may increase to complete paralysis. Complete or even partial loss of sensation is not common, as the sensory impulses are conveyed through the grey matter of the posterior cornua, which are, as a rule, not seriously affected. As soon as the descending degenerative changes commence in the motor tracts, the reflexes become exaggerated, and the limbs most commonly become rigid in the extended position. Sometimes if the extended limb be slightly bent, it will suddenly flex completely, apparently as soon as that point of flexion is reached which gives the flexors an advantage over the extensors. This condition has been termed "clasp-knife rigidity." In the later stages the limbs may become permanently flexed. There is no marked wasting of the paralysed muscles, nor are the electrical reactions of degeneration present. If the pressure affects the lumbar region the bladder may be paralysed, and retention, followed by dribbling, may result; but if it be above that point the bladder commonly empties itself periodically without the patient being able to influence the act by his will. The sensation of distension may, however, warn the patient in time to prevent his wetting his bed. In a case lately in University College Hospital the bladder acted purely automatically, but with such regularity that the child could be kept dry by being placed upon a bed-pan at fixed times. There is no incontinence of fæces. In the great majority of cases of slow compression of the cord the symptoms are bi-lateral, but in very rare cases one lateral half of the cord only is affected.

The symptoms due to pressure at the nerve-roots are common, and often precede those due to compression of the cord. Pressure on the posterior roots causes at first uneasy sensations referred to the terminal branches of the affected nerve. The pain in the pit of the stomach so common in caries in the dorsal region is due to this cause. The part supplied by the nerve may be hyperæsthetic. When the pressure becomes sufficient to block the root the part supplied by it becomes anæsthetic, but at the same time there may be intense neuralgic pain still referred to the terminal branches connected with the compressed root. This condition of "*anæsthesia dolorosa*" as it has been termed is characteristic of compression of the posterior root.

Pressure on the anterior root causes weakness followed by complete paralysis of the muscles connected with the compressed root. The paralysis may be preceded by spasm or twitching. When the pressure is sufficient completely to block the root and thus to cut off muscles connected with it from all connection with the cord, rapid wasting ensues and the electrical reactions of degeneration will be observed.

Acute Spinal Meningitis is a very rare and fatal complication of caries of the spine, but it is occasionally met with in those cases in which the destruction of the bodies of the vertebræ has exposed the dura mater so that it comes to form part of the wall of a chronic abscess. Even then it rarely if ever occurs, except as the result of decomposition of the discharges after the abscess has been opened, as a consequence of which the membrane may slough.

DIAGNOSIS.—The diagnosis of caries of the spine is made at the first sight of a patient affected by the disease, when once the angular deformity has taken place. It is, however, difficult before excurvation occurs, being indicated at this period only by the existence of pain in the back, and by some symptoms of spinal irritation. At this stage it may be mistaken for spinal or intercostal *neuralgia*, for *rheumatism*, or for *stone in the kidney*. The persistence, however, of a continuous fixed pain in the back should always lead to a suspicion as to the true nature of the disease, lest the grievous error be committed of treating as mere neuralgia or rheumatism what may turn out to be disease of the spine itself. Here the tenderness on pressure, the increased sensibility to the application of heat will determine the seat of the affection. The pain elicited by rotation or by antero-posterior movement is a very valuable symptom. In some cases pain on bending backwards is most complained of. The patient can stoop forwards, but if bent backwards suffers much. So also pressure on the head or shoulders greatly increases the pain of the part affected. The shape of the back, with loss of the natural curves of the spine with a tendency, though it be very slight, to projection of some of the spinous processes, the feeling of weakness in the back, the difficulty in rising from a sitting or horizontal position, in turning, or in standing on one leg unaided, the loss of the natural flexibility of the spine, and especially the occurrence of these symptoms in early childhood or youth, at a period when the other diseases with which it may be confounded rarely occur, and are still more rarely persistent, would lead one to suspect the existence of caries of the spine.

The diagnosis between *abscesses* localized in the situations mentioned, and those arising from diseased spine, is not always easy; as purulent collections of various kinds may form in the areolar tissue in the neighbourhood of the vertebral column, without any disease existing in it. Thus, a large psoas abscess descending in the sheath of the muscle and presenting under Poupart's ligament, may occur from some irritation of the areolar or fascial structures without disease of any of the vertebræ. In these cases of simple abscess, the diagnosis from the psoas abscess dependent upon vertebral disease is usually easy, as there will be an absence of all excurvation of the spine or even of tenderness along it. As psoas abscess dependent upon vertebral caries almost invariably presents in the groin, and a large abscess in the groin may arise from various other conditions, independently of such vertebral disease, the Surgeon must attend carefully to the diagnosis of these various conditions. *Abscess and fluctuating swellings in the groin* may arise from the following causes :—1, from large chronic collections of pus in the subcutaneous or intermuscular planes of areolar tissue ; 2, from disease of the kidneys with suppuration in the areolar tissue around it—perinephritic abscess ; 3, from pericæcal abscess (on the right side only) ; 4, from iliac abscess, whether forming merely under the iliac fascia, or dependent on disease of the pelvic bones ; 5, from hip-joint disease, the abscess being pelvic ; 6, from large buboes or glandular abscesses ; 7, from an empyema perforating the pleura and finding its way down behind the diaphragm ; 8, from serous or hydatid cysts ; and 9, from femoral hernia with fluid in the sac. These various collections may, however, with a little caution be readily distinguished from the ordinary form of spinal abscess that descends along the psoas muscle. In the first place, in all these cases there is an absence of that dorsal pain and tenderness, with more or less excurvation, which, though not invariably present, is commonly met with in psoas abscess. Then, again, if the collection be *perinephritic,* there will have been previous, or there are co-existing symptoms of renal disease. I have, however, seen an abscess dependent on caries of the vertebræ not only assume the perinephritic form, but open into the pelvis of the kidney, thus simulating chronic pyelitis. In this case the diagnosis was made by a careful examination of the pus, in which molecular masses of carious bone were found. The chemical and microscopic examination of the pus in all cases of doubt should never be omitted. If there be caries, it may present unmistakable evidence of the presence of disintegrated bone. If it occur in the *areolar tissue around the cæcum,* the pus will be peculiarly offensive, will present itself in a less distinct manner, and will probably be associated with symptoms of intestinal irritation. Moreover, periphrenitic or pericæcal abscesses being superficial to the iliac fascia, do not extend below Poupart's ligament except in some rare cases, in which the abscess is acute, and forces its way irrespective of the attachments of the fasciæ. Thus I have seen the pus in a pericæcal abscess pass under Poupart's ligament, and present as a large sloughy abscess at the upper and outer part of the thigh. In those rare cases in which an *empyema* has found its way between the layers of the abdominal muscles, and presented in the groin, the examination of the chest will point out the nature of the affection. In *abscess connected with disease of the hip-joint,* there will be special local evidences of the source of the pus. The only real difficulty consists in diagnosing a psoas abscess dependent on disease of the vertebral column, before it reaches the thigh, from *iliac abscess,* whether it take its origin in the loose areolar tissue of the iliac fossa, or be connected with disease of the corresponding bone; and in the latter cases the difficulty is often not a little increased in consequence of the iliac abscess finding its way into the sheath of the psoas muscle. If the iliac abscess be superficial to the fascia iliaca, it very rarely passes beneath Poupart's ligament, owing to the firm attachment of these two structures to each other. In very rare cases such abscesses find their way along the spermatic cord or down the femoral sheath, and thus leave the abdomen, but these could not be confounded with psoas abscesses. When the collection of pus forms beneath the fascia iliaca, there is nothing to prevent its extending to the psoas or passing down under Poupart's ligament, and the determination of its origin whether from disease of the ilium, or vertebræ, or from a strain, can be made only by the presence or absence of the symptoms of disease of the spine. Whenever the abscess is beneath the fascia, there are some signs of irritation of the ilio-psoas muscle, which are usually wanting when the pus is in the sub-peritoneal tissue. These signs are most marked when the abscess extends along the whole length of the psoas. There is then an inability to stand upright, to extend the leg, and pain is complained of in walking. Psoas abscess also, in many cases, appears on the thigh suddenly, the patient finding, on washing himself in the morning, that he has a large soft tumour in the groin; whereas iliac abscess comes on more gradually, and presents in a more diffused and less circumscribed manner.

Iliac and psoas abscesses require to be diagnosed also from certain forms of *aneurism of the abdominal aorta* or *iliac arteries;* which, having become diffused by rupture of their sac, have formed large non-pulsating extravasations in the sheath of the psoas in the iliac fossa. In such cases the previous history, the absence of distinct fluctuation, and possibly stethoscopic examination, together with the rapid increase of the tumour, will indicate the true nature of the case.

In other cases, again, when the abscess, after deeply burrowing, has perforated the fascia lata, its feel closely resembles that of certain *fatty tumours.* Here the possibility of diminishing the size of the swelling on pressure, the impulse on coughing, and the absence of a solid edge to the swelling, enable the Surgeon to effect the diagnosis.

From *femoral hernia* the soft and fluctuating character of the swelling, its gradual return when pressure is taken off, its situation external to or below the femoral vessels, and total absence of gurgling, constitute the chief distinguishing characters.

Large serous collections and *hydatid tumours* are occasionally met with in the iliac fossa and groin, presenting all the characters of chronic abscess; from which, however, the character of the fluid let out on aspiration will immediately distinguish them.

PROGNOSIS.—The prognosis is necessarily unfavourable. It has two aspects: 1, As to the persistence of Deformity; 2, As to the Life of the patient.

1. **Deformity.**—The angular curvature arising from caries of the bodies of the vertebræ is necessarily an incurable deformity. The diseased spine is soldered and held together by fusion of the partly destroyed vertebral bodies; and any attempt at straightening this excurvation would be attended by the greatest risk, from danger of exciting irritation of the spinal meninges, or opening the spinal canal. When excurvation has taken place, there has been loss of substance; and this cannot be repaired. Hence the spine must remain shortened in front and bent out posteriorly, giving rise to the ordinary forms of hump-back.

2. **Life.**—So far as life is concerned, the prognosis will depend on several conditions. The first is whether the disease is accompanied or not by suppuration. When suppuration occurs, much will depend on the extent of the caries: if several vertebræ be affected, so that the curve is very long, the disease is necessarily highly dangerous from the extent of osseous structure implicated. It was long ago remarked by Boyer, that the most fatal cases were generally those in which the spine preserved its straight position; whereas, when it was much curved, death seldom resulted. The truth of this remark I have had frequent occasion to verify; and the circumstance would appear to be owing to the fact that, when the spine continues straight at the same time that the bodies of the vertebræ are tuberculous and carious, ankylosis cannot occur, so that the spinal canal is open and the cord irritated; whereas, when they have fallen together and very considerable gibbosity has resulted, ankylosis more readily takes place, and thus an imperfect cure is effected. The size of the abscesses, and the amount of discharge from them, must also necessarily seriously influence the result. If they be very large, and continuously discharging, hectic and consequent death will probably supervene. The presence of sequestra which will not come away, and prevent healing, adds greatly to the gravity of the case.

The gravity of the prognosis is increased when symptoms of slow compression of the cord set in, but not to the extent that might have been supposed. A very large proportion of the cases recover even after complete paralysis or die from causes unconnected with the pressure on the cord.

Caries of the spine is more fatal in adults than in children. In those rare cases in which it commences after middle life it is almost invariably fatal.

Treatment.—The first principle in the treatment of caries of the spine is to take off the weight of the part of the body above the diseased vertebræ, and at the same time to fix the vertebral column so as to prevent the friction of the diseased surfaces against each other and to encourage recovery by ankylosis. This object may be attained by two methods: 1, the maintenance of rest in the horizontal position, and, 2, the application of some mechanical apparatus. These methods cannot be employed indiscriminately; one will be more suitable than another at different ages, in different stages of the disease, or according as it affects different portions of the column. Whatever method of securing rest be chosen no time must be lost in adopting it as soon as the existence of the disease is recognised.

Treatment by the recumbent position is very efficacious, and may often be used as an adjunct to other methods. If the patient be old enough to understand the importance of rest he may be laid on a properly constructed prone couch. The prone position is certainly preferable to the supine; for not only is the projecting angle formed by the excurvated spine not injuriously compressed, as it would be in the supine or lateral position, but the patient is more comfortable. At the same time, the back not being the lowest part of the body, there is less tendency to congestion of the diseased parts. Formerly the patient was thus kept in the recumbent position for many months, seldom less than twelve or eighteen, till all the acute symptoms had disappeared. Since the introduction of the treatment by the plaster jacket to be immediately described, this is no longer necessary. If the symptoms are very acute, the prone couch may be used for a short time, but as soon as possible the plaster jacket should be applied and the patient allowed to move about.

Treatment by Mechanical Support.—The most efficient of all means of treating caries of the lower dorsal and lumbar regions of the spine is the application of the plaster-of-Paris jacket as recommended by Lewis A. Sayre of New York. The following is a brief summary of the details of this method.

The patient being stripped to the waist, a thin closely woven vest without sleeves is drawn over the body. It must be stretched so as to lie perfectly smooth, and may be kept from wrinkling by a piece of bandage passing between the legs and pinned to its lower edge in front and behind. The patient is then placed under a tripod stand, to the apex of which is attached a block-and-fall arrangement carrying a horizontal iron bar, a padded collar is buckled round the head and chin, while padded stirrups are passed under the arms; straps are then passed separately from the collar and arm-stirrups to the iron bar above (Fig. 581). By shortening or lengthening these straps, the relative tension upon the head and arms can be adjusted with nicety. The indication that the proper amount of extension has been made with the pulleys, is the comfort experienced by the patient. He must on no account be raised completely from the ground. When thus suspended, the spine becomes straighter, the ears are lifted from the shoulders, and the diseased surfaces of the vertebræ are prevented from pressing upon one another.

A thick towel folded should be placed under the vest, over the fore-part of the abdomen. When the case is dry, this is drawn out, and thus space is left for expansion of the abdomen during meals. This precaution is a very important detail. Its omission may be attended by very inconvenient consequences.

Plaster of Paris bandages are then carefully applied round the body from immediately above the trochanters to the axillæ. Strips of thin perforated tin are then placed by the sides of the spine, and a second layer of plaster bandages passed round the whole (Fig. 581). The straps being now removed the patient is laid upon a mattress, great care being taken to keep the back extended while he is being moved lest the soft case be broken. As soon as he is upon his back the case must be carefully moulded to the crests of the ilia by firm pressure with the hands. If there is much projection of the spines a pad of soft lint or cotton wool must be placed on each side of the prominence to prevent injurious pressure. Sayre strongly insists on the importance of attention to details. The bandages must be of "crinoline muslin," which

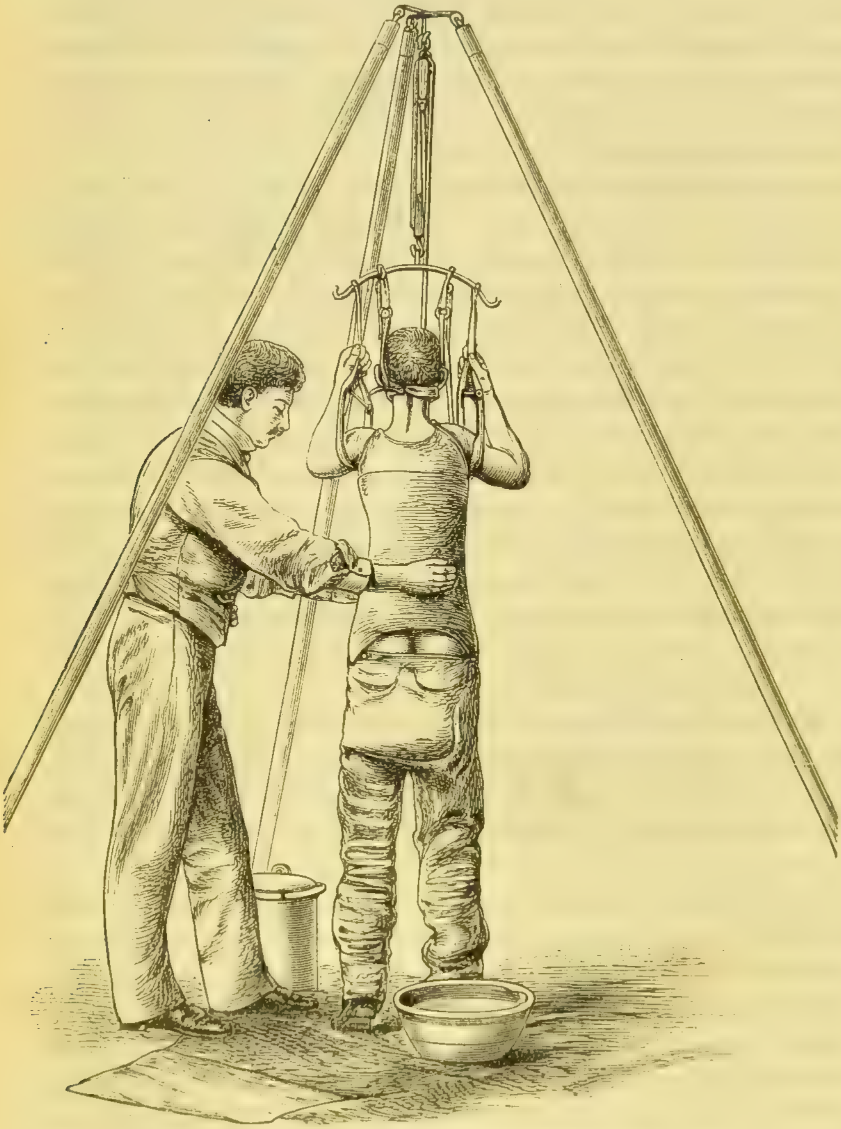


Fig. 581.—Application of Sayre's Plaster Jacket.

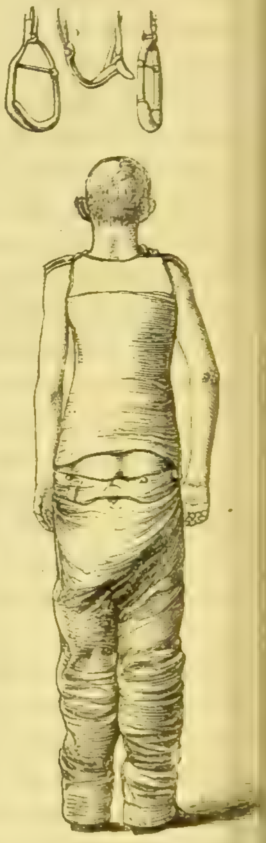


Fig. 582.—Sayre's Jacket Applied.

will hold sufficient plaster in its meshes ; the finest "Artist's plaster" must be used ; the woollen jersey must be elastic and fit accurately, and the case must be well moulded to the body by rubbing with the hands. When the case is dry a semilunar piece may be cut out under each arm and over each trochanter if necessary. The essential points to be attained by this treatment are, 1st. To extend the diseased spine to an extent sufficient to prevent friction of the carious surfaces against each other, not attempting, of course, to correct the angular deformity completely ; 2nd. To maintain the spine in the extended position by a light and firm casing accurately moulded to the pelvis below so as to obtain a fixed point and closely embracing the thorax above, so that the weight of the head and shoulders may not be borne directly by the diseased bodies of the vertebræ. A well-made plaster jacket may be worn from two to six months without being changed.

Since the introduction of this treatment by Sayre various modifications have been suggested. In young children the tripod and pullies are unnecessary, as the jacket may be applied whilst the child is held by its mother or an assistant in an upright position with its arms over its head. In acute cases it is wiser to avoid the upright position altogether. This may be done by cutting a number of strips of plaster bandage one and a quarter times the circumference of the trunk. These may be wetted with equal parts of mucilage (B.P.) and water, which will delay the setting. A sufficient number of these are then arranged on a waterproof sheet overlapping each other, as in the ordinary many-tailed bandage. The patient, having the woollen jersey applied, is then lifted and laid upon the bandages, which are folded over and rubbed smooth. There should be two layers of bandages, and the strips of perforated tin should be inserted between the first and second layer. This mode of application avoids any risk of dangerous extension of the diseased spine. After the application of a well-fitting plaster case there is usually great relief of pain, both in the spine and in the course of the nerves proceeding from the affected region. The respiration commonly becomes more easy. If the apparatus fits with sufficient accuracy the patient can bear the erect position and move about without pain.

It is evident that the jacket as above described cannot be of any use unless the disease is situated below the level of the folds of the axilla, as above this point the bandage cannot go. When the disease is above this point a special contrivance, termed by Sayre the "jury mast," is required to support the head (Fig. 583). This consists of two bars of soft iron passing on each side of the spine and accurately moulded to it, and united between the shoulders by a cross bar, from the middle of which a vertical curved bar passes up behind the neck to above the middle of the head. At the end of this is a transverse arched bar of iron fixed on a pivot, so as to allow of rotation. To this the head is suspended by a padded collar passing beneath the jaw and occiput. The two upright bars are enclosed between the layers of the plaster-jacket and thus the weight of the head is transmitted directly to the pelvis. Jackets made of softened leather or "poroplastic" felt may be used instead of the plaster apparatus. They must be moulded to the patient, either while he is suspended or lying upon his back, with the arms well raised above the head. The "jury mast" can be fitted to these if required.

For very young children a double Thomas's hip-splint, from the upper transverse bar of which a well padded head-rest extends upwards, will be found a very efficient means of ensuring rest. The child can be carried by the nurse or moved in bed without the least disturbance of the spine. When all signs of acute disease have disappeared, and the deformity alone remains, the apparatus shown in the accompanying figure may sometimes be worn with advantage (Fig. 584). It combines three principles in its action—1, a broad pelvic band, forming a firm basis of support round the lower part of the trunk; 2, lateral upright stems, terminating in crutches, by which the weight of the head and shoulders is taken off the diseased spine, and transmitted directly to the pelvic base; and 3, a posterior plate, which by means of a rachet can be brought to bear directly upon the excurvated part of the spine, and support, and in some degree rectify the position of this.

Whatever apparatus may be used it is of the utmost importance that the patient should not be allowed to dispense with proper support for at least six months after all pain or other signs of active disease have disappeared, otherwise he is almost certain to suffer from a speedy relapse.

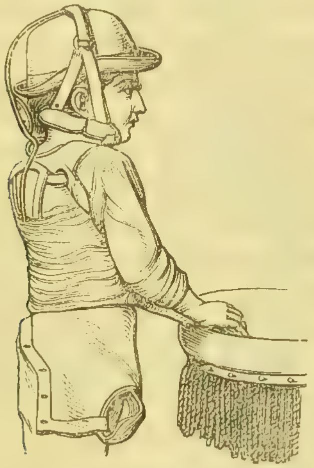


Fig. 583.—Apparatus for Disease of Cervical or Upper Dorsal Spine. Plaster Jacket with "Jury Mast." (Sayre.)

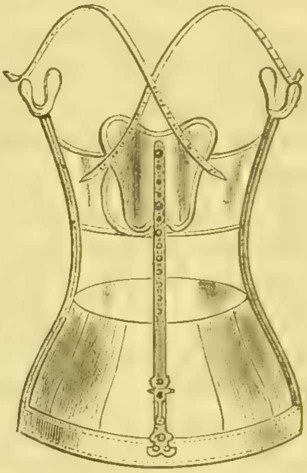


Fig. 584.—Apparatus for Supporting the Trunk in Vertebral Caries.

As before stated, the mode of treatment adopted must vary with the seat of the disease, the age and the circumstances of the patient. Treatment by the recumbent position alone is almost impossible amongst the children of the poor, as it requires constant attention from a nurse and a properly constructed couch which can be wheeled into the open air whenever possible. Even amongst the rich it is well to conjoin the recumbent position with the application of a leather or poroplastic splint. For the great majority of cases Sayre's plaster-jacket is the most efficient apparatus. It requires no materials that are not always at hand, and can be applied by the Surgeon without the assistance of an instrument maker. Its only disadvantages are that it cannot be taken off to wash the patient, and that it is apt to become foul and sores may form beneath it. In adults the plaster-jacket, or leather, or poroplastic should always be conjoined with the recumbent position. After all acute symptoms have subsided, the poroplastic or leather jacket will be found much superior to the old fashioned steel supports (Fig. 584).

Counter-Irritation by blisters, issues, moxæ, or the actual cautery, was formerly much employed. It is now generally recognised that it is worse than useless in children, and only very rarely of service in adults. In exceptional cases of caries of the spine in the adult accompanied by much pain, the actual cautery applied on each side of the spine may give great relief, and apparently aid in curing the disease. It must be used, however, only in the earliest stage of the disease. Nothing can be more unscientific or indicate a more profound ignorance of pathology than to use it after abscess has once formed.

The ordinary **constitutional treatment** that is adopted in strumous diseases must be employed in these cases. Much benefit will be derived from the use of cod-liver oil, iron, the phosphates, and above all good air—country or sea. As in all other cases where bone is diseased, at least three years must be devoted to the cure of a case of angular curvature. But that cure consists only in the preservation of life, not the removal of deformity, which is the inevitable result of carious ankylosis.

Treatment of Abscess.—The formation of abscess should, if possible, be prevented by the employment of the means above described. Should suppuration unfortunately take place, the danger is greatly increased. A chronic abscess connected with caries of the spine should never be allowed to point or burst spontaneously. It must be opened or the pus evacuated in some way as soon as it has arrived at a point at which it can be clearly recognised and safely reached.

Simple aspiration of a spinal abscess is seldom productive of a cure; but Billroth reports very favourably of aspiration, followed by the injection of an emulsion of iodoform in glycerine (Vol. I., p. 253). Further experience is required before the true value of this method can be ascertained; but as it seems free from danger, it certainly deserves a further trial.

Opening these large abscesses is accompanied by two dangers—1st, septic poisoning from decomposition of the discharges; and 2nd, more remotely the risk of hectic from the long-continued discharge kept up by incurable bone disease. The first of these may be avoided, and the second reduced to a minimum by the strictest attention to the prevention of putrefaction by the employment of some efficient system of antiseptic treatment, and by ensuring the best possible drainage.

In opening these abscesses an incision should first be made just large enough to admit the finger, which should be immediately passed into the cavity, so that it may be explored for sequestra before the pus escapes, while its walls are still tense. In dorsal or lumbar abscesses the finger may possibly be made to reach the diseased spine, and if a sequestrum be felt loose it might be removed. A psoas abscess may be opened before it leaves the abdomen, by an incision close above Poupart's ligament external to the line of the vessels. If it points at the inner side of the thigh an incision may be made in that situation as well, but this alone will never drain the whole cavity thoroughly, owing to the narrowness of the sac of the abscess, where it passes beneath the femoral vessels, and should, if possible, be avoided, as it is difficult to apply an antiseptic dressing so near the perinæum. It has been suggested by F. Treves that in cases of caries of the lower dorsal or lumbar vertebræ with psoas abscess more direct drainage may be obtained, the diseased vertebræ examined, and possibly sequestra removed by making a vertical incision in the space between the last rib and the ilium immediately internal to the outer edge of the erector spinæ; this muscle is exposed and drawn towards the middle line, and the quadratus lumborum may then be cut through close to transverse processes. The finger may now be thrust inwards along the anterior surface of a transverse process, so as to avoid the situation of the lumbar arteries. The tense sac of the abscess may then be felt. It is best opened by thrusting a pair of polypus forceps through its wall and expanding the blades. As soon as the pus flows, the finger may follow the forceps and feel for sequestra. This mode of opening has now been frequently adopted with satisfactory results, and in suitable cases is certainly to be recommended. After a lumbar or psoas abscess has been opened for some time, and the discharge reduced to a very small amount, the patient may be allowed to move about with a proper plaster support, through which an opening may be made opposite the sinus for dressing the wound ; or a poroplastic or leather support may be made which can be removed when necessary. Antiseptic dressing must be continued as long as any discharge persists.

The **Treatment of Paraplegia** in spinal caries presents nothing special. The limbs may be rubbed to maintain their nutrition. No operation such as trephining the spine is justifiable, as the compression is due to disease of the membranes and not to displacement of the bones.

DISEASE OF THE CERVICAL SPINE.

Caries of the cervical spine presents several points requiring special consideration. It is much less frequent than in the dorsal and lumbar regions.

The signs are the usual ones of pain, rigidity, and swelling, diffused and ill-defined. But there is in the cervical region no tendency to angular excurvation. This is owing partly to the fact that the concavity of the natural curve is backwards and partly to the shallowness of the bodies of the vertebræ not admitting that coalescence after their destruction, which is characteristic of the same disease in the dorsal and lumbo-dorsal regions. But the patient is unable to support or to turn his head ; he holds it in his hands when in the upright position, and rotates the whole body when he attempts to look round. There will be pain on any attempt at movement, whether rotatory or antero-posterior, and on downward pressure on the vertex. Although no angular curvature can, for the reason just stated, take place in this region, the spinous processes may become irregular, one or two projecting more than the others.

Disease of the Articulations between the Atlas and Axis, and between the Atlas and Occipital Bone constitutes one of the most serious forms of vertebral caries. In these cases there are pain and swelling, with great difficulty or absolute inability to move the head. Patients affected with this disease present a remarkable as well as a distressing appearance. The sterno-mastoid muscles are remarkably tense and prominent, and the neck being perfectly rigid, they are unable to turn the head, but when they want to look round have to twist their whole body; at the same time, the weakness in the neck usually compels them to support the head with both hands, putting one under the chin, the other under the occiput, and so holding it. The disease may suddenly terminate fatally by luxation of the atlas forwards, compression of the cord, and asphyxia; or more slowly by hectic or gradual interference with the respiratory functions.

Retro-pharyngeal abscess may form as a consequence either of disease of the bodies of the upper cervical vertebræ, or the articulations of the first two. It commences with induration and swelling of the areolar tissue at the back of the pharynx. Subsequently the swelling becomes softer and fluctuation perceptible. The posterior wall of the pharynx is pushed forwards against the posterior nares, giving a peculiar nasal tone to the voice, and if the abscess be large it may cause difficulty in breathing and swallowing. The formation of retro-pharyngeal abscess in young people should always lead to an examination of the cervical spine. The abscess may burst into the pharynx or may extend outwards, and point at the side of the neck, coming forwards under the sterno-mastoid.

The **Treatment of Disease of the Cervical Spine** must be conducted on the same principles as that of angular curvature, by absolute rest and attention to the general health. The actual cautery may sometimes be of use in adults before suppuration has taken place. When there is much pain it must be applied on each side of the spine at the back of the neck. As great and immediate danger may result from the sudden displacement of the vertebræ and consequent compression of the cervical cord, the head requires to be steadied by proper apparatus, calculated to support and steady its movements. Sayre's jacket with the "jury-mast" (Fig. 583) is the most efficient apparatus for disease below the first two vertebræ. A leather splint embracing the shoulders and the upper part of the chest and back fitted with a broad collar for the neck and a support for the chin and occiput will be found to suit many cases. In disease of the atlas and axis, the head must be fixed absolutely so that no movement is possible. The patient should be confined to bed in the recumbent position, with a heavy sand-bag on each side of the head. Gentle weight extension by means of a collar holding on the chin and occiput attached to a cord passing through a pulley at the head of the bed is often useful for relieving pain. When the acute symptoms subside, an apparatus, such as is represented in Fig. 331, Vol. I., may be applied.

Retro-pharyngeal abscess is a serious complication, for when it bursts into the pharynx it empties itself imperfectly, and decomposition of the discharges ensues, thus perpetuating the disease. To avoid this, J. Chiene of Edinburgh recommends that it should be opened early, when possible, by an incision made behind the sterno-mastoid. The carotid vessels and pneumogastric nerve must be pushed forwards without injuring the sheath of fascia in which they are enclosed. The abscess can thus be treated antiseptically. In this way he successfully treated a large abscess containing eight ounces of pus.

OTHER DISEASES OF THE SPINE.

Gummata of the Spine.—Cases of partial destruction of the bodies of the vertebræ by the formation of syphilitic gummata commencing beneath the periosteum have been recorded. The disease closely resembles ordinary caries of the spine in its symptoms, and the diagnosis can be made only by the history, and the co-existence of other syphilitic affections. The treatment is mechanical support in addition to the ordinary internal remedies.

Rheumatoid Arthritis may affect the spine. The intervertebral discs atrophy and bony outgrowths form from the bodies which may bridge over the spaces between them. The natural movements are thus restricted.

Beyond this it causes no very definite symptoms, and it requires no special treatment.

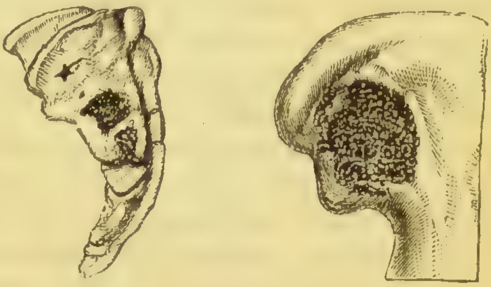
Tumours of the Spine.—The bodies of the vertebræ are not uncommonly the seat of secondary cancerous growths. Primary sarcomata also are occasionally met with. The symptoms are pain, usually very severe, localized at one spot in the spine, followed after a time by some excurvation. The tumour projects sooner or later, if the patient survives sufficiently long, into the spinal canal and compresses the cord, causing paraplegia. Except in cases in which the tumour is secondary the diagnosis from dry caries is scarcely possible. Early supervention of paraplegia, with slight excurvation, in a patient past middle life, would, however, suggest the presence of a tumour.

Tumours within the Spinal Canal.—Tumours within the spinal canal may arise inside or outside the dura mater. Outside the dura mater lipomata are most common though these are rare. Within the dura mater syphilitic gummata, sarcomata, myxomata and psammomata are occasionally met with, and fatty tumours have been found in a few cases. The symptoms produced by these growths are those of slow compression of the cord, for which I must refer the reader to works on medicine. If unrelieved by treatment they inevitably cause death, and syphilitic gummata alone are influenced by drugs. Writing in 1886, W. R. Gowers suggested that Surgery might ultimately be able to cope with meningeal tumours, those actually implicating the cord being of course beyond the reach of operative interference. In 1887 a middle aged man came under his care with symptoms of a tumour compressing the cord in the upper dorsal region, causing almost complete paraplegia and anæsthesia below the level of the fifth dorsal nerve. On June 9th, 1887, Victor Horsley undertook its removal. The spines and laminæ of the third, fourth, and fifth dorsal vertebræ were cut away, the dura mater opened, and a myxoma removed which was pressing on the right side of the cord. On January 28th, 1888, the patient was exhibited at the Medico-Chirurgical Society, having completely recovered from all his symptoms except a little stiffness in the legs. The wound was soundly healed and no artificial support was required.

CHAPTER LI.

DISEASE OF THE SACRO-ILIAC JOINT.

Disease of the Sacro-Iliac Articulation is a rare affection. With but few exceptions, systematic writers on Surgery were, until recently, altogether silent upon this subject. Boyer and Chelius mention the disease; but it is only by Nélaton that any detailed description of it has been given. This may be partly accounted for by its rarity, and partly, perhaps, by its having not unfrequently been confounded with some of the varieties of disease of the hip or spine.


Sacro-iliac Disease in its early stage.
Fig. 585.—Sacrum. Fig. 586.—Ilium.

Sacro-iliac disease is essentially a chronic affection, lasting for months or years. It appears to be tubercular in its origin. I have never seen it in young children, and in all the cases which form the basis of these observations it has occurred in young adults from 14 to 30 years old. The exciting causes of the disease are obscure; I have not been able to trace it to blow or injury in any of the cases that have been under my care, although there can be very little doubt that such causes might excite it.

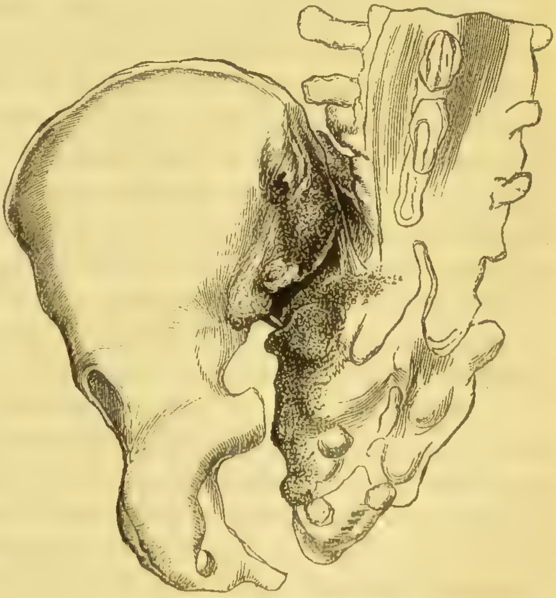


Fig. 587.—Sacro-iliac Disease, more advanced.

Pathology.—The disease may commence primarily in the pelvic bones, in the articular structures of the sacro-iliac junction, or between the lateral epiphysial plate of the sacrum and the body of the bone which do not unite till the twenty-fifth year. The annexed drawings (Figs. 585, 586), taken from a boy who died of tetanus from the irritation of an issue, six weeks after the commencement of disease in the sacro-iliac articulation, show erosion of the cartilages in patches. The next drawing (Fig. 587), taken from a man about 30 years of age, who died of this affection after nearly two years of suffering, shows the disease in its most advanced stage. The bones were bare and rough, but not necrosed; they were completely deprived of their incrusting cartilage. There was no deep erosion of them, no cavity, no sign of tuberculous infiltration; no evidence, in fact, of primary osseous disease. The ligamentous structures of the articulations were only partially destroyed. The interosseous ligament was especially in a sound state; it had preserved to a great extent its firmness, and required to be divided with the scalpel in order to expose the interior of the joint and the opposed osseous surfaces. The structures that appeared chiefly to have suffered were the synovial and cartilaginous elements of the joint. The synovial membrane is normally but imperfectly developed in the sacro-iliac articulation, but it may possibly undergo changes analogous to those which take place in the tubercular disease of other joints.

Symptoms.—The symptoms characteristic of this affection arrange themselves in five distinct groups—viz., Pain, Swelling, Lameness, Alteration in the Shape of the Limb, and Abscess. These we must study separately.

1. **Pain.**—One of the earliest symptoms is a sensation of painful weakness at the lower part of the back and sacrum, increased by movements of the body in walking, stooping, or even in standing, giving the sensation as if the body were falling asunder. The pain is increased by any effort that calls the respiratory muscles into action, such as coughing, sneezing, or laughing, and is greatly aggravated by straining at stool. As the disease advances, the pain becomes more continuous, and of a gnawing or rheumatic character. Its intensity varies greatly; in some instances it is throughout slight, except on movement, in others it is most intensely agonizing, the patient shrieking with agony, and being unable to obtain rest in any position. The pain in the gluteal region may in some cases be due to irritation of the lumbo-sacral cord, which lies in close contact with the articulation. The pain is confined to the gluteal region and groin, and does not extend far down the limb. When the patient is lying on his back or side, the limb on the affected side may be ab- or adducted, or the head of the thigh-bone may be pressed up against the acetabulum, without any increase of pain, provided the pelvis be fixed by the pressure of the hands. If this be not done, considerable, even intolerable pain will be experienced on moving the limb. So, also, if the Surgeon seize the sides of the pelvis in his hands, and move them to and fro, or press them together transversely, or separate them by pressing the anterior superior spines asunder, pain will be elicited, the affected joint being then influenced by the movement. There is often diffused tenderness on pressure over the gluteal region; but this is less about the hip-joint than in coxalgia, and gradually increases as the finger is pressed backwards upon the sacro-iliac articulation, so that it may at last be localized in a small spot.

2. **Swelling.**—A puffy intumescence is perceptible early in the disease, along the line of the affected articulation. It assumes a somewhat elongated appearance from above downwards, and does not extend to any distance outwards under the gluteal muscles, nor does it invade the natural hollow behind the trochanter. As the disease advances, and suppuration takes place, the swelling increases materially, and assumes different and peculiar characters, owing to the formation and diffusion of abscess.

3. **Lameness** is an early symptom. The patient walks insecurely; has a feeling of want of proper support to the body; leans forward, and uses a stick. He puts the foot of the affected side to the ground, but does not tread upon it so firmly as upon the other; he cannot stand on it, or twist himself suddenly round. As the disease advances, the powers of support and progres-

sion diminish, and at last the patient becomes unable to assume the erect position, lying in bed usually on the sound side.

4. **Alteration in the Shape of the Hip and Length of the Limb** are an early and marked symptoms. From the very commencement of the disease, the limb on the affected side will seem to be longer than the sound one; the tip of the inner malleolus being usually, as the patient lies on his back, half an inch below the level of the same point of bone on the opposite side. But on close examination, it will be found that the measurement from the anterior superior spine to the inner malleolus gives the same result on both sides; hence the elongation cannot be owing to any change that has taken place in the bones or in the three large joints of the lower extremity, but must be dependent on some disturbing cause situated beyond the anterior superior spine of the ilium. On more close investigation, this point of bone is found to be at a lower level, and at the same time more prominent, than its fellow on the opposite side: the displacement is thus produced, not by any obliquity of the pelvis consequent on a twist of the lumbar spine, as in hip-joint disease, but by the tilting forwards and rotation downwards of the whole side of the pelvis; for the displacement which takes place is a double one. The swelling of the affected articulation not only pushes forwards, but rotates downwards, the anterior and superior portion of the ilium; and hence the anterior superior spine is not only at a lower level, but is also more prominent on the diseased than on the sound side. The limb itself usually lies straight, and is wasted and enfeebled.

5. **Abscess** occurs only at a late period of the disease. Many months, a year or more, may elapse before suppuration is fairly established, or, at all events, before the formation of pus is so abundant that it can be recognized as an abscess. I have observed abscess in connection with this disease in five situations—viz., over the articulation, in the gluteal and in the lumbar regions, within the pelvis, and in connection with the rectum.

The first indication of abscess is met with over the diseased articulation. The puffy swelling which is there perceptible in the earlier stages of the affection, gradually softens, until at last fluctuation is established in it. From this point it may spread outwards into the gluteal region, nearly as far as, but not enveloping, the trochanter; or it may take another course and stretch upwards, forming a considerable accumulation in the loin, upon and just above the crest of the ilium. These forms of sacro-iliac abscess are *extra-pelvic;* the other varieties are *intrapelvic.* These latter are of three kinds. In one form the pus passes out of the sciatic notch, and under the great gluteal muscle; in the next it gravitates downwards into the ischio-rectal fossa, and presents by the side of the rectum; and in the third variety which I have observed, the abscess opens into the gut, abundant puriform discharge takes place *per anum*, and, flatus from the bowel passing into the suppurating cavity, a tympanitic abscess results.

Prognosis.—The prognosis of this disease is always most unfavourable. I am not prepared to say that it is of necessity fatal, but I have never seen a patient recover after the full development of the disease, and after suppuration had set in. I have, however, seen a case cured, in which, from the history of the symptoms, the thickening over the sacro-iliac articulations, and the permanent displacement of the side of the pelvis, there was every reason to believe that this disease had existed. But in this instance no abscess had formed.

Diagnosis.—The diagnosis of sacro-iliac disease is important, and not always easy. There are five distinct affections with which it may be confounded—viz., neuralgia of the hip, sciatica, spinal disease, disease of the hip-joint, and disease of the pelvic bones.

1. *Neuralgia of the hip* in young females may readily enough be confounded with the earlier stages of sacro-iliac disease. But the widely spread and superficial nature of the pain which is not limited to the neighbourhood of the diseased articulation, the co-existence of the hysterical temperament, and the sex of the patient render the true nature of the affection sufficiently clear. The obliquity of the pelvis which occasionally occurs in neuralgia of the hip, and causes apparent elongation of the limb, is readily removed when the patient lies on the back; whereas, in sacro-iliac disease, position does not affect the displacement of the limb on the affected side.

2. *Sciatica.*—In this affection, the age of the patient, usually more advanced than that of the subjects of sacro-iliac disease; the seat of the pain, below the articulation, and its extent down the back of the limb, the tenderness being in the line of the great sciatic nerve, and not over the articulation, and the fact that it is not increased by pressing on the iliac spines; with the absence of elongation, will enable the Surgeon to effect the diagnosis.

3. From *spinal disease,* the diagnosis is usually sufficiently easy; for, although the situation of an abscess arising from caries of the vertebræ may be the same as that which is occupied by the collections of pus resulting from sacro-iliac disease, yet in the vast majority of cases of caries of the spine, excurvation of the vertebræ has become prominently marked by the time that the abscess has assumed so great a magnitude as to occupy the inferior lumbar or gluteal regions. In those rare cases in which, as in an instance that was some time ago under my care, caries of the vertebræ, with consecutive abscess, takes place without any angular curvature, it will be found that the patient complains of tenderness on the Surgeon percussing the spine opposite the seat of disease; that the spinal column has lost its flexibility, moving stiffly and as a whole; that there is an absence of that elongation of the limb on the affected side, dependent on displacement of the wing of the pelvis, which is so early observable in sacro-iliac disease; and lastly, that examination of the sacro-iliac synchondrosis neither elicits pain nor reveals swelling or any of the other signs of disorganization of that articulation.

4. *Disease of the hip-joint* is the affection that is most easily confounded with sacro-iliac disease, and that from which it is of most importance to make the diagnosis. It is especially from that variety of hip-disease which commences in the acetabulum, primarily involves the pelvic bones, and only secondarily implicates the joint, that it is difficult to distinguish sacro-iliac disease; and the importance of recognising the nature of the case is great when we reflect that an error in diagnosis might lead to the performance of an unnecessary operation on the hip-joint. The diagnosis between coxalgia in all its forms and sacro-iliac disease may be made by attention to the following circumstances:—

a. The seat of pain on pressure varies. In hip-disease the patient suffers severely when pressure is exercised deeply in the hollow behind and above the trochanter, or against the anterior part of the hip-joint. In sacro-iliac disease, little or no pain is experienced on pressure in these situations; but tenderness is elicited by pressing upon the sacrum and along the line of junction between that bone and the ilium, behind and altogether away from the hip.

b. The movements that occasion pain are different in the two diseases. In hip-disease, abduction and rotation outwards, and pressure of the head of the thigh-bone into the acetabulum, aggravate the sufferings of the patient. In sacro-iliac disease the thigh may be moved in all directions, ab- or adducted, rotated, flexed, or extended, whilst the patient is lying on his back, without any increase of suffering, provided the side of the pelvis be fixed by the Surgeon. Should this precaution not be taken, the movement impressed on the thigh will be communicated to the diseased articulation, and will necessarily cause pain.

c. The signs connected with the alteration in the length of the limb differ in the two diseases. In hip-disease there may be, and usually is in the advanced stages, considerable shortening. This never occurs in sacro-iliac disease.

d. The alteration of the level and of the prominence of the two anterior superior spines, in sacro-iliac disease, may be confounded with that arising from the obliquity of the pelvis usually occurring in the early stages of coxalgia. But here also the diagnosis may be effected by observing that the displacement of the bone in sacro-iliac disease is permanent, and is not influenced by position. The obliquity of the pelvis in hip-disease, giving rise to apparent elongation of the limb, is dependent on a twist in the lumbar spine, which may be rectified by placing the patient on his back, and using a little manipulation. The alteration in the level of the two ilia, in sacro-iliac disease, is not modified by change of position, or by any movement that may be impressed upon the spine.

5. *Disease of the pelvic bones* may of course occur independently of any affection of the sacro-iliac articulation; and, when so occurring, it most commonly commences at a distance from the joint—the crest of the ilium, the tuberosity of the ischium, or the acetabulum, being the usual seats of the disease. When it occurs in the first of these two situations, the resulting abscess seldom attains a very large size, and is altogether above or below the synchondrosis, the outline of which can be felt clear and unobscured by swelling of any kind. When the abscesses are opened, the sinuses that result will lead directly down to the rough and carious bone, examination of which will leave no doubt as to the nature of the case. In these cases, also, no change takes place in the length of the limb, or in the position of the side of the ilium.

When the acetabulum is affected, the difficulty of diagnosis may be greater, in consequence of the large size and often intrapelvic nature of the abscesses. But here the same circumstances that enable the Surgeon to effect a diagnosis in ordinary coxalgia—viz., the pain in movement influencing the hip-joint merely, and the alteration in length of limb, as determined on measuring from the anterior superior spines—will prevent his falling into error as to the true nature of this disease.

Treatment.—With respect to treatment I have but little to say, and that by no means satisfactory. The treatment must be conducted on the same general principles that guide us in the management of cases of carious diseases of the spine. The great object is to prevent the formation of abscess. If the cure be fortunately accomplished, the patient will probably recover with a limb that, though weakened, is but little impaired in utility; for, the sacro-iliac junction being naturally a fixed joint, it matters little if, in the adult, it become ankylosed by disease. Long-continued rest in the prone position; fixing the pelvis, hip-joint, and thigh by means of a large leather cap and splint, or a plaster of Paris bandage, which should embrace the whole of the limb from above the crest of the ilium to the sole of the foot; counter-irritation, in the earlier stages, before suppuration has set in (after that has occurred it is worse than useless); the administration of cod-liver oil, iron, and suitable tonics, are the means to be employed. When abscess forms, this must be opened in a suitable and convenient spot, with antiseptic precautions; and the powers of the patient must be kept up by ordinary dietetic means and medicinal tonics, with the view of procuring ankylosis; but, unfortunately, little advantage usually follows the treatment beyond the mitigation of suffering and some prolongation of life. When once suppuration has set in, our hopes of a cure are materially lessened. I am not prepared to state that the affection is inevitably fatal when it has reached this stage, but certainly very frequently it is so. The abscess must, if possible, be opened and treated by some efficient antiseptic method. If decomposition of the discharges occurs the profuse discharge will probably induce hectic or destroy the patient by albuminoid disease of the viscera. If the abscess points over the joint it should be laid freely open and the articulation exposed and scraped. C. H. Golding-Bird in one case trephined the joint and thus reached a psoas abscess connected with the front of the articulation; the patient made a good recovery.

CHAPTER LII.

DISEASE OF THE HIP-JOINT.

Hip-disease presents so many points of peculiar and serious importance, that it is usually, and not improperly, described as a distinct affection, apart from other joint-diseases. Like all these it may be acute, subacute, or chronic, and most commonly occurs in strumous subjects. It is most commonly met with before the age of puberty. Out of 48 consecutive cases, of which I took notes, I find that in 16 only did it commence at or after fifteen years of age, and, of these, in 6 cases only it happened above twenty. The collected statistics of cases appear to give a very similar proportion. It is commonly attributed to slight causes, such as over-exertion in a long walk, a sprain in jumping, a fall, or sitting in the wet.

Forms of the Disease.—All the inflammatory affections attacking the coxo-femoral articulation are usually confounded under the term "Hip-Disease" or "Coxalgia." This is too general an expression; and we shall find included under it several distinct forms of disease that differ from one another in pathology, symptoms, result, and treatment. On looking at the hip-joint from a surgical point of view, we find it to be composed of three distinct parts—viz., the soft structures, the acetabulum, and the head of the thigh-bone. Any one of these may be principally or primarily affected; and we may accordingly divide hip-joint disease into three distinct forms—Arthritic, Acetabular, and Femoral. This division is not purely pathological, for in all forms when the later stages are reached, all the component parts are more or less extensively affected.

General Phenomena of Hip-Disease.—Before proceeding to describe each separate form of coxalgia in detail, we may consider briefly the conditions which are more or less common to each variety of the affection—viz., Pain, Attitude, Imperfect Mobility, Suppuration, Sinuses, Dislocation, and Ankylosis.

1. **Pain.**—The pain in hip-joint disease varies greatly according to the form which the affection assumes. In the more chronic forms of the disease it is at first slight, and, perhaps, referable rather to the knee than to the hip; this may be explained by the irritation of the articular branch of the obturator nerve, causing a referred pain to be felt in the terminal branches at the inner side of the knee-joint. Both the hip and knee receive also articular branches from the anterior crural and sciatic nerves. That from the obturator, however, enters the round ligament, and is perhaps for this reason implicated early in cases in which the disease commences in the head of the femur.

In the *arthritic* form the pain is always very acute, even intense, seated in the joint itself, and greatly increased by any movement, however slight, of the limb. In the *acetabular* form of the disease the pain is not at first referred to the joint, but rather to the iliac fossa or side of the pelvis; it afterwards becomes severe, gnawing, and deeply seated in the articulation. However slight the pain may be, it is always greatly increased by moving the limb, by pressing the surfaces of the articulation together, or by forced abduction or rotation.

2. The **Attitude** of the limb is peculiar, and varies during the course of the disease. In the early stages the limb is usually slightly flexed, abducted and rotated outwards, or in other words assumes the position of natural rest. The cause of this position has been the subject of much discussion. It has been proved experimentally by Bonnet and others, that the limb can be made to assume this attitude by forcibly injecting fluid, so as tensely to distend the capsule. The accompanying figure well shows this fact. It is from a photograph kindly furnished me by A. E. Barker, of a preparation made by himself. The right hip-joint was forcibly distended with fluid injected through a hole, drilled into it through the ilio-pectineal eminence. That the limb may therefore assume the position from distension of the capsule by effusion from the synovial membrane cannot be doubted; but in the great majority of cases of hip-disease there is no reason to believe that any such distension takes place. That the position is not merely mechanical is shown moreover by the fact that in the early stages of the disease it usually disappears under chloroform. It may, however, be assumed that the position taken by the limb when all the ligaments are tensely stretched by injecting the joint, is also that in which there would be the most perfect general relaxation if the fluid were let out; this position would therefore be involuntarily assumed by the patient when the capsule is inflamed. It has also been pointed out by Barker that in full extension "the leverage of the femur acting on the Y-ligament, and the tense anterior part of the capsule as a fulcrum," will force the head of the femur against the acetabulum, and for this reason the patient involuntarily keeps the thigh slightly flexed.

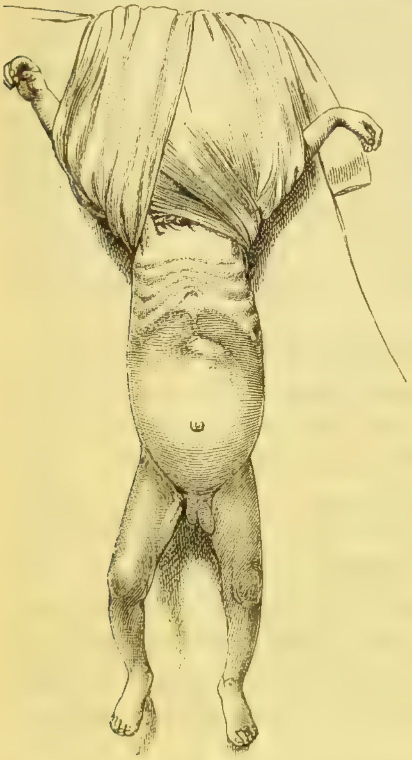


Fig. 588.—Position assumed by the limb on forcibly distending the capsule of the hip-joint with fluid.

Hilton attributed the position of the limb to a reflex contraction of the muscles surrounding the joint, consequent upon the anatomical distribution of the nerves, it being a rule in all joints that they receive branches from the same nerves that supply the muscles acting directly upon them. According to this view the flexion, abduction, and rotation outwards are due to the stronger muscles prevailing over the weaker. It has been suggested also that the position may be due to the direct irritation of the flexors and external rotators which lie more immediately in contact with the capsule than the extensors and internal rotators.

When the limb is abducted, if the patient be put in the erect position, the pelvis is tilted in such a way that the anterior superior iliac spine of the diseased side will be found to be somewhat lower than its fellow; at the same time the sound limb is adducted to a degree corresponding to the abduction of the affected side, and thus the two limbs are brought parallel to each other. The knee is flexed, partly on account of the lowering of the side of the pelvis and the flexion of the hip-joint, and partly because by putting the toes only to the ground, the elasticity of the foot is brought into play, and the pain prevented that would arise from the jar of the limb if the patient trod on the heel. The position assumed by the affected limb gives rise to an apparent elongation. Often in these cases of apparent lengthening there is actual shortening, but measurement from the anterior superior spinous process to the inner malleolus on each side shows the fallacy of this appearance.

As the disease advances, the position of the limb undergoes a complete change; the flexion remains and is increased, but at the same time the thigh becomes adducted and rotated inwards, so that the knee is carried against the lower part of the sound thigh. The cause of this position has been the subject of as much difference of opinion as that of the earlier displacement. In some cases it is undoubtedly due to destruction of the head of the bone and partial or complete dislocation. In these cases it is accompanied by distinct shortening with displacement of the trochanter above Nélaton's line. (Vol. I., p. 614.) Much more commonly, however, it sets in long before there are any signs of extensive destruction of the head of the bone, and must then arise from other causes. Busch has suggested that it may be due to the erosion of the upper and posterior wall of the acetabulum, so constantly met with as one of the earliest destructive processes in hip-disease. In consequence of this the head is displaced upwards and backwards, so slightly at first as not to give rise to signs of dislocation, but enough when the ilio-femoral ligament is unsoftened to cause adduction of the limb. The altered position of the limb has been ascribed also to softening and yielding of the thinnest part of the capsule, the posterior and outer, while the inner and anterior part, which is much stronger, retains its toughness; to the external rotators becoming implicated early in the disease, as they lie most closely in contact with the capsule, and thus ceasing to oppose the adductors and internal rotators; and lastly to the position assumed in bed by the patient when the diseased hip becomes too tender to bear any pressure. Probably all these causes are more or less concerned in the production of the adducted position, each acting in a different degree according to the circumstances of the case.

When adduction sets in, the position of the pelvis undergoes a change. In order to bring the limbs parallel and in a straight line with the body, the patient must now raise the pelvis on the affected side and abduct the sound limb, thus giving rise to apparent shortening of the limb on the side of the disease. This may occur without any or with very slight real shortening, the amount of which can be ascertained only by measurement.

The displacements of the pelvis and limb are accompanied by corresponding changes in the position of the spine. Owing to the tilting of the pelvis, there is a lateral curve produced in the lumbar region, the concavity of which looks towards the elevated side of the pelvis, and in order to keep the body straight, there is a compensating curve in the opposite direction higher up. At the same time the fixed flexion of the thigh is compensated for by an antero-posterior curvature of the lower spine with the concavity forwards, or as it is termed *lordosis*. This conceals the flexion of the hip-joint, so that the two limbs may lie side by side in bed apparently straight, when in reality the diseased hip is flexed to a considerable angle. When the limbs are in this position, if the hand be passed under the lumbar spine, it will be found to be arched forwards, not touching the bed. In order to estimate the amount of flexion, the plan recommended by H. O. Thomas is the best. As the patient lies on his back, the sound limb should be flexed to the full extent at the hip and knee, and pressed upon firmly till the lumbar spine becomes straight, and the hand can no longer be passed between it and the bed ; the thigh of the affected limb will then be raised from the bed, and the true angle of flexion becomes apparent. The degree of adduction or abduction is best recognized by putting a tape across from one anterior superior spine to the other, when the angles formed by the limbs with this line are at once clearly seen.

The alterations in *length* are recognized by measurement from the anterior superior spine to the inner condyle of the femur or the inner malleolus, the limbs being placed as accurately as possible in the same position on the two sides. If greater accuracy is required, the plan described in the chapter on Fractures (Vol. I., p. 615) may be adopted. Theoretically real lengthening may occur in consequence of effusion into the joint, but practically the amount so caused is too small to be recognized by measurement. True shortening may arise from destruction of the head of the bone, dislocation, and want of growth. In old cases it is well to measure the tibia separately, and to compare it with the sound limb. In this way the proportion of shortening due to general want of growth of the limb may be estimated roughly.

3. **Limitation of movement** is a constant symptom in all forms of hip-disease. The degree of limitation of flexion is ascertained by grasping the side of the pelvis with one hand, while the thigh is slowly raised from the bed with the other. In this way it is easily ascertained how much of the apparent flexion is due to movement of the pelvis and lumbar spine, and how much to true movement in the joint. The degree of possible extension is recognized by the method of ascertaining the angle of flexion recommended by H. O. Thomas. To ascertain the limitation of abduction or adduction, a tape may be passed across the pelvis from one anterior spine to the other, and another tape may be held at right angles to this to indicate the normal position of the limb when straight ; the limb may then be gently moved from side to side, and the degree of mobility noted. In estimating the possible amount of rotation, the hip and knee must be flexed, and the condyles of the femur grasped and rotated with one hand, while the pelvis is steadied with the other. It may be taken as a safe rule, that if flexion, rotation outwards, and abduction, can be carried to such a degree as to place the limb in the attitude assumed by a tailor when sitting cross-legged, there is no disease of the hip-joint. This position puts the round ligament firmly on the stretch, and if the head of the femur is diseased, would cause considerable pain.

4. **Suppuration** is not a necessary consequence of inflammation of the hip-joint, though in strumous subjects it more commonly occurs than not. We often see the *arthritic* variety run its course without the formation of pus, although occasionally suppuration may occur early with severe constitutional disturbance and great pain. When the disease begins in the bones, abscess usually forms sooner or later, being the direct consequence of the presence of diseased bone. When the disease commences in the femur, suppuration taking place early with severe constitutional disturbance, is usually associated with

more or less extensive necrosis of the head of the bone. In the acetabular form, abscess is often one of the earliest signs of serious mischief, sometimes preceding the other signs of hip-disease.

The abscess in disease of the hip usually appears first behind the joint, the pus having escaped from the capsule by perforating the posterior part which is the thinnest. It then, in most cases comes gradually forwards beneath the gluteus minimus and medius. Having reached the anterior border of the glutei, it passes beneath the tensor vaginæ femoris, and the upper part of the sartorius, forming a swelling in the upper part of the thigh below the anterior superior iliac spine. From this point it often burrows downwards, and opens behind the thick band of fascia into which the tensor vaginæ femoris is inserted, in the lower part of the upper third of the thigh. Sometimes the abscess appears in front of the joint, though this is rare, owing to the thickness of the capsule in this situation. When the acetabulum is perforated, the abscess forms between the obturator internus and the bone, the muscle being at last extensively destroyed. The pus is confined beneath the pelvic fascia, which becomes greatly thickened, and shuts off the abscess from the general cavity of the pelvis. As the pus increases in quantity, it burrows upwards, and perforates the attachment of the pelvic fascia at the brim of the pelvis, coming to the surface above or under Poupart's ligament. It very rarely if ever escapes by the small sciatic notch along the course of the tendon of the obturator internus, and it never reaches the great sciatic notch, being shut off by the thickened pelvic fascia. When there is extensive necrosis of the pelvic bones, the abscess may find its way into the true pelvis, and point beside the rectum; but this is rare in hip-disease. Still more rarely the pus may escape from the front of the joint and get into the psoas muscle, forming a psoas abscess. When this occurs, it is probably due to the existence of a communication between the synovial membrane of the joint and the bursa beneath the psoas in front of the articulation.

5. When the abscesses have burst or been opened, **Sinuses** are left behind, an attentive examination of the position and direction of which is of importance in forming an opinion as to the seat of the osseous disease. There are three situations in which sinuses are met with, which vary according to their point of origin from the abscess, and the position of the diseased bone.

1. When the abscess has originated in acute arthritis or primary synovial tuberculosis, or when the disease has commenced in the head of the femur and subsequently implicated the joint, the pus usually takes the course above described and reaches the surface below and a little in front of the great trochanter, about the insertion of the tensor vaginæ femoris into the fascia of the limb. A sinus in this situation indicates therefore almost invariably disease chiefly implicating the soft structures of the joint or the head of the femur. A similar sinus may, however, result from disease of the trochanter not extending to the joint. 2. When the sinus is in the gluteal region it may have originated in an abscess escaping from the back of the joint as above described but not extending so far downwards, but not unfrequently a similar sinus leads down to disease of the pelvic bones, a portion of the dorsum ilii being commonly the part involved. 3. The sinus may open in the pubic region either above or below Poupart's ligament; in this situation it is almost certainly diagnostic of disease of the pelvic bones. When it

appears *above* the ligament it almost invariably leads into an intrapelvic abscess due to perforation of the floor of the acetabulum; when it opens *below* the ligament it very frequently is connected with disease of the ramus of the pubes or ischium.

It is only by attention to these circumstances that the Surgeon is enabled in many cases to form an approximate opinion on the seat and extent of the osseous disease; for the diseased bone is often so covered in by healthy osseous structure, as when the inner aspect of the great trochanter is affected, or by inflamed and indurated tissues, that the probe cannot touch it; or the sinus may be so tortuous that a straight probe cannot follow its windings. Sayre's vertebrated probe (Fig. 508) is very useful in these cases.

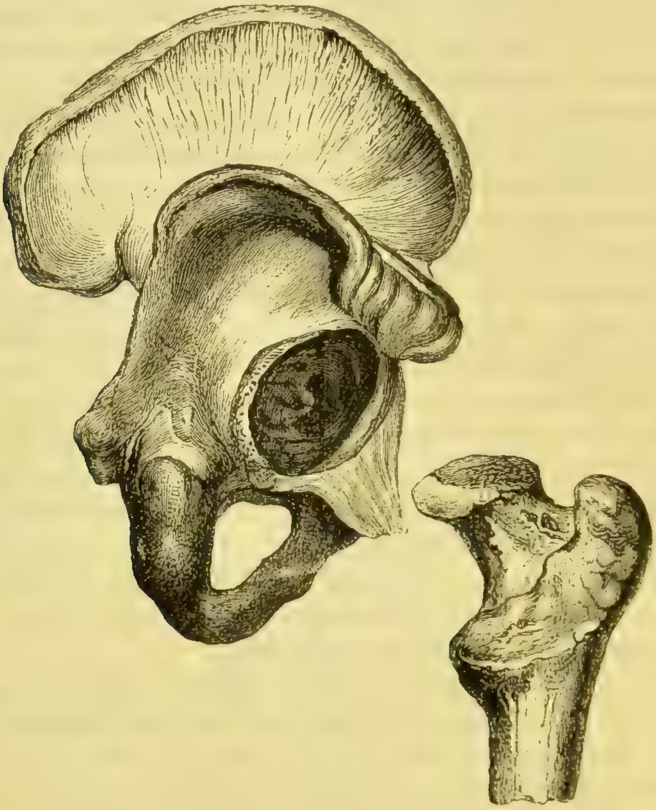


Fig. 589.—Acute Disease of Hip-joint in an Adult. Destruction of Head of Femur. Softening of Ligaments. Dislocation on to the Dorsum Ilii.

6. **Dislocation.**—In the advanced stages of hip-disease, dislocation of the head of the thigh-bone commonly occurs, and may arise from three causes:—*a.* The capsular ligament may give way in consequence of inflammatory softening and ulceration, and the head of the bone be thrown out of the cavity by the action of the surrounding muscles. *b.* Caries and partial destruction of the head of the thigh-bone may have taken place, so that it no longer fills up the cotyloid cavity; and the ligaments, and often the upper margin of the acetabulum being at the same time destroyed, it slips out on the dorsum ilii (Fig. 589). *c.* In some cases of acute arthritis dislocation occurs early from rupture of the capsule by over-distension with pus or inflammatory exudation.

The dislocation is almost invariably of the dorsal variety, the head of the bone escaping above the tendon of the obturator internus. The limb assumes the ordinary attitude of that displacement, being shortened, flexed, adducted, and rotated inwards. In rare cases, however, when the limb has been kept perfectly extended on a splint, the head of the bone may be displaced so as to lie on the anterior part of the dorsum ilii immediately behind and below the anterior inferior iliac spine, the trochanter being directed backwards and the limb everted and extended. This position is probably always the result of treatment in which the limb has been kept perfectly extended but without sufficient care being taken to prevent eversion.

It not uncommonly happens when the disease commences in the femur that the whole epiphysis of the head becomes separated from the shaft and remains in the acetabulum while the trochanter is drawn upwards and rests on the dorsum ilii. In those cases the head commonly necroses and remains as a foreign body in the acetabulum indefinitely prolonging the disease unless removed by operation.

The occurrence of dislocation is, in the great majority of cases, preceded by the formation of abscess in and around the joint; but in some instances it happens in consequence apparently of softening of the ligaments, the head of the bone being thrown out of the acetabulum without the supervention of any sign of suppuration. In these cases a false joint may be formed upon the dorsum ilii, where the bone lodges. When it is lying in a suppurating cavity it will always be found to be in a carious state, and then no attempt, or at most an imperfect one, is made at the construction of an articulation around it. The acetabulum after the displacement of the head of the bone often becomes filled by a mass of pulpy granulation-tissue which has been supposed by some to take part in pushing the head of the bone out of place; this, however, is improbable.

Dislocation may take place in any variety of the disease, but it is most common in those in which the head of the thigh-bone is more or less destroyed. In these cases it is usual to find the upper and posterior margin of the acetabulum with which the diseased head has been in contact, extensively destroyed, so that the cavity is enlarged in this direction. In this way the anterior and lower part of the cavity is relieved from the friction of the diseased head of the femur, and is frequently found to be undergoing repair, the surface which has been denuded of cartilage being covered with healthy granulation-tissue. In macerated specimens of this kind the upper part of the acetabulum, against which the diseased head of the femur has been lying, shows the porous spongy appearance indicative of rarefying osteitis, while the lower part, which has been relieved by displacement of the femur upwards, shows evident signs of repair, new bone having been formed closing up the cancellous spaces, and often rendering the structure more dense than natural. These appearances show that the acetabulum when affected secondarily, will readily repair if relieved from the irritation of the friction of the diseased head of the femur against it. When the acetabulum is primarily affected, or extensively destroyed secondarily, the head of the femur is commonly dislocated on to the dorsum ilii; but when perforation has taken place it has been known to slip into the pelvis.

7. **Ankylosis** may occur either with or without previous suppuration. If the joint have suppurated and the head of the bone be thrown on to the dorsum ilii, a false joint may eventually form, or osseous ankylosis in a more or less faulty position may take place. If the head of the bone continue in the

acetabulum without suppuration, osseous ankylosis may ensue with but little shortening of the limb.

PATHOLOGY AND SYMPTOMS OF THE VARIOUS FORMS OF HIP-DISEASE.—It is not often that the opportunity presents itself of examining a hip-joint in the earlier stages of coxalgia before complete disorganization of the joint has taken place. It is impossible therefore to define with certainty the exact starting point of the disease in every case. There is no reason to doubt that the hip-joint is liable to all the various forms of destructive inflammation already described as occurring in other joints. Thus we meet with Acute Arthritis (p. 337), arising in some cases apparently from exposure to cold, in others from acute osteomyelitis and necrosis of the epiphysis of the head, in others, from extension of suppuration outside the joint into the cavity of the articulation, and in rare cases from general blood-poisoning, as in pyæmia or puerperal fever, and gonorrhœa. More commonly the disease runs the course of white swelling or strumous arthritis (p. 345), and in the hip as in other joints the morbid process may commence in the synovial membrane or in the cancellous tissue of the bones. When arising in bone the head of the femur is so constantly the seat of the primary disease, that this variety may be termed Femoral Coxalgia. It must be remembered, however, that clinically it is impossible in these cases to determine the actual starting point of the disease with any degree of certainty. Thus R. J. Godlee has reported a case in which the disease was running the ordinary chronic course of white swelling of the hip, and was apparently receiving great benefit from treatment when the child died from tubercular meningitis. The examination of the hip showed two small tubercular centres, each forming a cavity about the size of a pea, filled with soft granulation-tissue. One was situated in the growing bone in contact with the Y-shaped cartilage of the acetabulum, and the other in the same tissue between the epiphysis of the head and the neck of the femur. The synovial membrane was injected, and its fringes swollen and becoming converted into granulation-tissue.

Lastly the hip-joint is liable, especially in adults, to a form of disease which may be termed Pelvic or Acetabular. This commences as inflammation, terminating in necrosis of the rami of the pubes or ischium, the disease subsequently extending to the acetabulum, and thus giving rise to disease of the joint.

Arthritic Coxalgia, Acute Arthritis of the Hip.—Symptoms.—In this form of the disease the patient is seized with signs of acute inflammation of the joint, coming on rather rapidly, and with great constitutional disturbance and pyrexia. The pain in the joint is most excruciating, accompanied by spasms and twitchings of the limb, and marked by nocturnal exacerbations. The suffering is so intense, that the patient cannot bear the slightest movement of the limb; a fit of coughing, the weight of the bed-clothes, or the shaking of the bed by a person leaning against it will give rise to the most intense agony; and in the intervals of his suffering the patient is in constant fear of a return of the pain, to which he looks forward with much anxiety. In these cases the limb is flexed, everted, abducted, perfectly helpless, and motionless: the nates will be found flattened, and there is usually some fulness about the anterior part of the joint, or to its outer side, in the hollow behind the trochanter. There is also theoretically true elongation of it, in consequence of the capsule becoming distended with fluid, and pushing the head of the bone downwards, but this seldom, if ever, occurs to such an extent as to be recognizable by measurement. On measuring in order to ascertain the true length, it is necessary to examine the two limbs together, and to place the sound in exactly the same position as the diseased one; unless this be done, error will very probably creep in, for, on measuring the lower extremity from the anterior superior iliac spine to the lower border of the patella or the inner ankle, it will be found to be of greater length when abducted or extended than when adducted or bent.

In some cases the distension of the capsule with synovial fluid, as the result of the inflammation in the joint, may be so great as to lead to its rupture, and to the sudden dislocation of the head of the bone on to the dorsum ilii, with great pain and much shortening; this, however, is of very rare occurrence, the dislocation seldom taking place until after abscess has formed within the joint, and the articulation has been thus destroyed.

Results.—In this, the arthritic form of hip-disease, various terminations may take place ; the result depending greatly upon the constitution of the patient, the cause of the inflammation, and on the manner in which the affection is treated. In the most favourable circumstances, as the inflammation subsides, the disease falls into the subacute condition, and recovery gradually but very slowly takes place, with a limb that continues stiff and partially ankylosed, as well as wasted and somewhat shortened from disuse. Sometimes complete ankylosis occurs without the previous formation of abscess. In the majority of instances, however, abscess forms. The pus then escapes from the capsule usually at the posterior part. When this occurs the acuteness of the symptoms often diminishes, and the abscess slowly burrows forwards and points near the tensor vaginæ femoris. After it is opened, if decomposition of the discharges is not prevented, the patient may be worn out by the profuseness of the discharge ; or great shortening taking place, either by the destruction or separation of the head of the bone or its dislocation out of the acetabulum, the cavity of the abscess may ultimately contract, the sequestra, if any are present, may exfoliate, the carious surfaces heal, and the sinuses close after years of suffering. In the most favourable circumstances, when once the joint has been acutely inflamed, a year or perhaps two will elapse before the patient can use his limb with any degree of security. The safety of the patient depends in a great measure on preventing the occurrence of suppuration. In a certain proportion of cases in which the disease commences with the acute symptoms above described, suppuration rapidly follows in spite of any treatment. In many of these the arthritis is dependent on acute osteomyelitis and necrosis of the epiphysis of the head, and on opening the abscess this may be found as a sequestrum in the cavity of the joint. Such cases are not distinguishable at first from those in which the disease is purely arthritic, commencing in the soft parts. If the patient be of feeble constitution acute arthritis of the hip, from whatever cause arising, can rarely be prevented from reaching the stage of suppuration, but if he be tolerably healthy, and the disease be not due to acute osteomyelitis, suppuration may be avoided, and then recovery may take place with a useful though somewhat stiff and crippled limb. This form of hip-disease is rare in the adult, and when it occurs is usually pyæmic or puerperal, and consequently most commonly fatal. In children it is less dangerous.

Pathology.—The pathology of acute arthritic coxalgia is the same as that of acute arthritis in other joints (p. 329). Surgeons have referred its origin to all the component parts of the joint. Aston Key believed the round ligament to be very frequently the starting point of the inflammation, and in the Museum of University College we have a beautiful wax model, supposed to illustrate the mode of origin; but it is not possible from this to say whether the disease commenced in the ligament itself or in the synovial membrane covering it. Probably all the forms of acute arthritis described as occurring in other joints may occur also in the hip.

Chronic Strumous Arthritis of the Hip, White Swelling of the Hip, Femoral Coxalgia.—*Symptoms.*—The disease usually commences very insidiously. It assumes a subacute character, and is chiefly met with in children. The first symptom that usually attracts attention is, that the child limps and walks in a peculiar shuffling, hopping manner; he does not stand firmly upon both feet, but rests on the toes of the affected limb, the knee of which is bent. The limb will be seen to be everted, somewhat abducted, slightly flexed upon the thigh, with the knee partly bent, and apparently longer than the other. This is, however, apparent, and not real; for on laying the child on its back, it will be found that the pelvis is placed obliquely; the anterior superior spine on the affected side being at a lower level than that on the sound one, and at the same time turned somewhat forwards. Measurement of the limb from this point to the ankle will show that there is no alteration in its length. The causes of this peculiar attitude have been already described (p. 458). At the same time that these symptoms are noticed, the child usually complains of pain in the hip, especially on pressing over the front of the joint, or behind the trochanter; this is increased by standing, walking, or any attempt to bear upon the joint; abduction also, and rotation of the limb outwards, or forced extension, are particularly painful, and any concussion of it, as by striking the heel or knee, will greatly increase the suffering. At this stage of the disease, for the reasons already given, the patient will often refer to the knee rather than the hip as the seat of pain, and a careless Surgeon might be misled and treat the wrong joint; the more so, as there is not unfrequently a good deal of cutaneous sensibility about the inner side of the knee-joint (p. 457). Limitation of movement (p. 460) forms one of the earliest symptoms of the disease. On turning the child upon its face it will be observed that the nates are somewhat flattened, the fold being in a great measure obliterated; and, if it be a female, the labium on the affected side will be seen to be placed at a lower level than on the sound one.

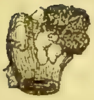


Fig. 591. — Carious Head of Thigh-bone after Excision.

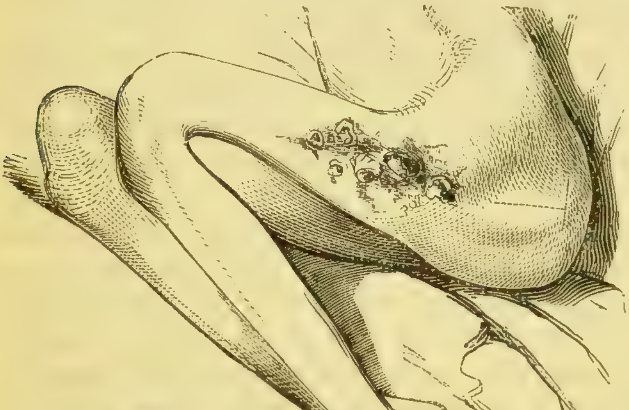


Fig. 590.—Chronic Disease of Hip-joint. Sinuses on outer side of Thigh.

As the disease advances, abscesses may form at any part in the vicinity of the joint. They most commonly occur under the glutei muscles and tensor vaginæ femoris ; but sometimes at the anterior part, under the pectineus muscle. When in this situation, they occasionally give rise to very severe pain down the inner side of the thigh by exercising pressure upon the obturator nerve, which may sometimes become tightly stretched over the wall of the subjacent abscess. In the later stages of the disease the acetabulum is not unfrequently perforated, and the pus then accumulates between the pelvic fascia and the bone, destroying the obturator internus to a greater or less extent, and finally making its way upwards, and pointing at Poupart's ligament (p. 461).

It is about this period that the change from the abducted to the adducted position (p. 459) takes place, followed by true shortening of the limb (Fig. 589). The shortening of the limb arises in chronic cases partly from want of growth consequent upon disuse, but it is chiefly due in most cases to destruction of the head of the bone, usually accompanied by dislocation upon the dorsum of the ilium. In some cases the remains of the dislocated head can be felt through the thin and weakened muscles in its new situation.

Pathology.—It is very rarely that the opportunity occurs of examining a hip-joint in the earlier stages of coxalgia. By the time the patient dies or where excision is performed, the ligaments are swollen and softened, the synovial membrane is represented by a pulpy mass of granulation-tissue, the cartilages have more or less completely disappeared, and the denuded osseous surfaces both of the acetabulum and femur are in a state of fungating caries. The cases running the clinical course just described, may commence as primary tubercular inflammation of the synovial membrane, or as tubercular caries of the bones secondarily extending to the synovial membrane. The evidence derived from the few cases which have been examined at an early stage, tends to prove that the former is the exception, and the latter the rule, and moreover that the bone in which the disease commences is almost invariably the femur. The growing tissue between the epiphysis of the head and the neck, or beneath the articular cartilage, seems to be a common starting point for the disease. The following appearances found in a child about eight years old, who died in University College Hospital of pneumonia, and whose body was carefully examined by Wilson Fox, is a good example of the early conditions met with in tubercular arthritis of the hip. The symptoms of hip-disease had existed only about six weeks.

The joint, which, including the acetabulum and capsule, was removed entire, contained a considerable quantity of dirty yellow pus. The ligamentum teres was flattened and covered with spots of yellow lymph ; it was much softened, tearing with the greatest ease. The synovial membrane was generally greatly thickened, intensely injected, of colour varying from bright red to dull orange, and covered by spots of yellow lymph. The cartilage lining the acetabulum appeared to be healthy, except just around the insertion of the ligamentum teres, where it was softer and more gelatinous-looking than normal for about one to two lines. The cartilage incrusting the head of the femur appeared at first sight to be entirely unaffected.

On making a vertical section through the acetabulum, and the head and neck of the femur, the great trochanter was found to be unossified, with the exception of a point in its centre, and its connection to the bone was weak and easily torn asunder. The epiphysis of the head was almost completely ossified; the line of junction being still, however, marked by a band of bluish and very hard cartilage, which extended for about three lines on each side across the bone. In the centre of this, extending both into the epiphysis and the diaphysis, was an eburnated portion of bone, yellow, hard, dense, and compact, these peculiarities being most marked in the portion belonging to the diaphysis. The cancellous spaces of this portion seemed to have been infiltrated with tubercle which had subsequently undergone calcification. In most parts this mass contrasted strongly in colour and in consistence with the reddened cancellous tissue. The incrusting cartilage, though generally appearing healthy superficially, could now be seen to be a good deal worm-eaten on its deep surface, and indeed, destroyed at one or two points. Where the mass of hard bone came near the surface, the reflexion of the synovial membrane was destroyed. Below this, in the neck and the upper part of the shaft, the cancellous tissue was very lax, the walls being very thin, and the medulla filling them extraordinarily red. The medulla at the commencement of the medullary canal, about one inch and a half below the trochanter, was exceedingly red and vascular. Occupying many spots of the cancellous tissue, and also one or two of the reddened medulla, were many little masses of the size of millet-seeds, looking like transparent cartilage, hard and resisting, yielding no juice, not breaking down at all easily under the finger, torn with difficulty by the needle, and when torn showing great numbers of nuclei and fibres. They pervaded the whole bone, and were found also in the acetabulum, but in smaller numbers. Some of them could easily be enucleated where the medulla was soft, others could be separated only with difficulty from the cancellous bone.

From this account it is easy to perceive that the disease was tubercular; that it commenced in the osseous structures, chiefly of the femur; and that it secondarily implicated the soft articular structures.

Acetabular Coxalgia.—In the acetabular form, the disease originates in the pelvic bones, and the articulation and head of the thigh-bone are only secondarily involved. The disease of the pelvic bones has more of the character of necrosis than of caries; but the two morbid conditions are in many cases co-existent, the acetabulum being carious, whilst the rami of the pubes and ischium are necrosed. The soft articular structures speedily become disorganized; the cartilage incrusting the head of the thigh-bone is destroyed; the femoral head itself becomes eroded; but the disease does not extend into the neck or trochanters. This form of hip-joint disease is more common in adults than any other variety.

The **Symptoms** are usually obscure in the early stages, but become very unequivocal as the disease advances. There is pain around the hip rather than in the joint itself; this, however, becomes tender on pressure, and the patient cannot bear on the limb, but no alteration takes place in its length, although it becomes greatly wasted. Abscess invariably forms, perhaps at first within the pelvic cavity; but it soon presents externally. Sometimes it passes down by the side of the rectum, or through the sciatic notch to the gluteal region; but generally it points near the pubes, under Poupart's ligament. Hectic comes on; the sufferings are greatly increased; and death from exhaustion commonly ensues in this, which is by far the most fatal variety of hip-disease. In cases of this form, dislocation, though it is met with now and then, rarely takes place. Sometimes, however, the destruction of the acetabulum is so extensive that the head of the thigh-bone penetrates it, and passes into the pelvic cavity. Dislocation is most frequent when the disease has destroyed the head of the bone ; so that no impediment is offered to the action of the muscles around the joint, and the bone slips from its position in the cavity of the acetabulum.

Prognosis of Hip-Joint Disease.—The prognosis in cases of diseased hip must be regarded from two points of view—1, as concerns the Life of the Patient ; 2, as to the Utility of the Limb that will be left.

1. **Life.**—Disease of the hip-joint, and of the contiguous osseous structures, is dangerous to life in proportion to the abundance and the long continuance of the suppuration ; and this is dependent partly on the patient's constitution, but chiefly, and in the first degree, on the extent and nature of the osseous disease. In the *arthritic* form of coxalgia, suppuration is often prevented by rest and appropriate treatment; and when this is the case, the patient will usually recover. If suppuration take place in cases of this kind, recovery need not be despaired of ; but convalesence will be greatly protracted. In such cases much will depend on the patient's constitution. If that be highly scrofulous or there be tubercular disease elsewhere, the prognosis becomes correspondingly bad.

When the bones that enter into the composition of the hip are the primary seat of disease, the case assumes a much graver aspect, and even then under proper treatment, there is a good prospect of cure. The head of the bone, denuded of its incrusting cartilage, softened and carious upon the surface, may be thrown on to the dorsum ilii ; profuse and long-continued suppuration will ensue, yet, under good and careful management, and without operation, I have seen recovery take place.

In those cases in which the disease is primarily *femoral*, and dependent upon tubercle in the head of the thigh-bone, the prognosis is not favourable, for although in a certain proportion spontaneous cure may take place under proper treatment even without operative interference, a large number die from general tuberculosis or worn out by hectic induced by the long-continued suppuration.

The condition of the *pelvic bones* is one that more materially than any one other circumstance influences the prognosis in cases of coxalgia. When the acetabulum is perforated intrapelvic abscess will probably form, pointing above Poupart's ligament; and whether the head of the thigh-bone be dislocated or not, I believe that death must necessarily ensue, unless the diseased osseous structures be excised. If the acetabulum be merely superficially carious, the condition need not seriously affect the prognosis. In these cases the head of the bone becomes dislocated, and this very displacement is the first step towards the cure of the disease in the acetabulum. The surface of this cavity, which is roughened, and deprived of its incrusting cartilage, speedily becomes covered by granulations, which become developed into fibrous tissue, and in the course of a short time the whole cavity becomes filled up by a dense fibroid growth.

When the disease extends to the osseous structures around the acetabulum, such as the rami of the ischium and pubes, the tuberosity of the ischium and the upper lip of the acetabulum, and even the dorsum of the ilium, it usually partakes more of the nature of necrosis than of caries. In extensive pelvic disease such as this, natural means are quite unable to effect a cure, and the patient must die of hectic or intercurrent disease, unless recourse be had to excision of the head of the thigh-bone and the whole of the necrosed and carious osseous structures.

The report of the "Committee of the Clinical Society appointed to inquire into the value of excision as a means of treating disease of the hip-joint in childhood," contains the most accurate information we possess concerning the death-rate of hip-disease, in the statistics furnished by Howard Marsh of the cases treated by him in the Alexandra Hospital for Hip-disease in Childhood, between 1867 and 1879. The total number of cases amounted to 401. These may be divided first into 277, or 69 per cent. in which suppuration took place, and 124, or 31 per cent., in which no abscess formed. The following table shows the results. Those classed as "verified cures" were examined by the Committee. The value of the statistics is enhanced by the fact that the patients at the Hip Hospital are kept under treatment or watched as out-patients as far as possible until the final result is known. Patients requiring operation are sent elsewhere, and consequently are placed in a separate class.

	WITH SUPPURATION.	WITHOUT SUPPURATION.
A. Verified cures	52	31
B. Reported cures	33	24
C. In process of cure and still under observation	7	5
D. Untraced :—		
a. Apparently cured on discharge	9	15
b. Apparently convalescent	9	11
c. In progress on discharge	41	9
E. Indefinite cases	5	7
F. Cases still under treatment	14	9
G. Under treatment, apparently incurable	3	0
H. Deaths	87	13
I. Operations	17	0
	277	124

These figures yield a percentage of 42·3 of cures or convalescents, 24·2 of incomplete cases, and 33·5 of deaths. Of the 87 cases in which death took place after suppuration, 16 died of meningitis, 20 died of albuminuria and dropsy, 3 of albuminuria and phthisis, 5 of phthisis, 9 of exhaustion, 2 of erysipelas, 1 of pyæmia, and 24 from unknown causes, 19 of which had been discharged as incurable. In the 13 non-suppurating cases which terminated fatally, death took place from the following causes: 7 from meningitis, 1 from phthisis, 1 from tubercular pneumonia, 1 from croup, 1 from intercurrent disease (nature unknown), and 2 from unknown causes.

In the cases with suppuration ending in cure the average duration of treatment was about 4 years, in the non-suppurating cases it was about 3. In the fatal suppurating cases the average duration of life was 3¼ years.

2. **Utility of the Limb.**—When once the bones or ligaments entering into the hip-joint have become inflamed, more or less lameness will invariably result, however carefully conducted the treatment may be. The amount of lameness may consist in a mere stiffness about the hip, a difficulty in abduction, in flexion of the thigh on the pelvis, or in free rotation; or it may

extend to absolute uselessness of the shortened, withered and deformed limb, which hangs powerless from the pelvis, suspended as it were by the ilio-femoral ligament, and slightly flexed and adducted. The extent of lameness will depend chiefly upon the form of the disease, and to some extent upon the treatment adopted; but some will always be left. When the coxalgia is *arthritic*, and suppuration has not taken place, ankylosis of a more or less complete form will usually ensue; and if the thigh have been kept in the straight position, a sufficiently useful limb will be left, but slightly shortened, and possessing free compensating movement in the lumbar spine, enabling the patient to swing it with facility as he walks. If suppuration have taken place, and the head of the bone have been destroyed or dislocated, the limb, even under the most judicious treatment, will be left considerably shortened, weakened, wasted, and more or less adducted, with the knee carried somewhat forwards, as well as inwards, and the patient walking often most imperfectly and with great difficulty on the point of his toes.

Of the 83 cases of cure from the Hip Hospital verified by the Committee, 69 are described as "good cures," 11 as "moderately good," and 3 as "cures with considerable lameness."

Diagnosis.—In making the diagnosis of coxalgia, care must be taken not to confound it in its early stages with an ordinary attack of *rheumatism*, a mistake that not unfrequently happens. The alteration in the shape and position of the limb, the obliteration of the fold of the nates, and the limitation of the pain to one joint, will usually prevent the Surgeon from falling into this error. With *disease of the knee*, care must be taken not to confound hip-disease, in consequence of the pain in the early stages being commonly referred to the former joint; here the absence of any positive sign of disease about the knee, and the existence of all the signs of disease in the hip that have already been noticed, will enable the Surgeon to recognize the true seat of the affection. *Lateral curvature of the spine*, accompanied by neuralgic tenderness in the hip, occasionally gives rise to apparent shortening of the limb with pain and rigidity; but in these cases the existence of the spinal affection, the superficial nature of the pain, and the absence of increase of suffering when the joint is firmly compressed, or of painful startings at night, will indicate the true nature of the affection. *Abscess* may occasionally, though rarely, form in the vicinity of the hip without that joint being diseased. Should this take place towards the anterior aspect of the articulation under the pectineus muscle, it may, by its pressure upon the obturator nerve, occasion pain in the thigh and knee, as in those cases in which the articulation is affected; here, however, the sound state of the joint at its posterior and outer part, the absence of all obliquity of the pelvis, and of the other signs of the true hip-disease, will enable the diagnosis to be effected. The diagnosis from *sacro-iliac disease* has been described at p. 455. In infants *inflammation of the glands in the groin* may simulate hip-disease, as the child flexes and adducts the limb, and screams at any forcible attempt at extension. It can be distinguished from hip-disease by feeling the glands if the child be not too fat, and by observing that the thigh can be completely flexed and freely rotated without causing signs of pain.

Acute hip-disease may be mistaken for *Perityphlitis*. The child lies with the thigh flexed on the abdomen, and complains acutely when the right groin is pressed. The diagnosis is easily effected by anæsthetizing the patient, when manipulations of the parts will decide the precise seat of the inflammation.

It may be taken as a general rule that if the thigh can be flexed to a right angle without any movement of the pelvis, perceptible to the hand placed on the anterior superior spine and the neighbouring part of the crest, and if while in that position with the knee flexed, the femur can be abducted and rotated outwards till the heel is over the sound thigh, there is no disease of the hip. This movement is so readily made in young children that it is an easy mode of excluding hip-disease, though of course if it is impossible, it does not prove its presence, as limitation of mobility may be due to causes outside the joint.

Treatment.—The treatment of disease of the hip must be conducted with reference to the form of the disease, the acuteness of the attack, and the severity of the local and constitutional symptoms. In all cases, this affection must be managed in accordance with those general principles that guide us in the treatment of inflamed joints.

It is of especial importance to adopt early measures. If we wish to prevent the occurrence of suppuration, dislocation, or ankylosis, the child must, on the supervention of the *earliest* symptoms of impending mischief about the joint, be put under proper constitutional treatment, and complete rest of the limb must be secured by a proper splint. By early attention a cure may be effected ; whereas, if the case be neglected in its first stages, the utmost the Surgeon can do is to save the life of the patient.

When the disease is of the **acute Arthritic** kind, the patient must of course be kept in bed, and absolutely at rest. No treatment will be of the slightest avail, unless we adhere rigidly to that principle which is paramount in the management of all acutely inflamed joints—absolute rest. In inflammation of the hip-joint, there are three methods of securing this : 1, by means of a weight attached to the limb ; 2, by the long splint ; and 3, by Thomas's hip-splint.

The particular method employed must depend somewhat upon the acuteness of the symptoms and the position of the limb. As a Thomas's splint requires to be accurately fitted to the limb, and should be especially made for the patient, one of the two first means has usually to be adopted at the commencement of the treatment. Of the two methods, that by the weight-extension is the better, as it completely relieves the painful startings, and is adapted to all cases, however great the degree of flexion or lateral displacement may be. In applying extension by means of a weight, the following plan should be adopted. The patient is placed upon a hard mattress. The angle of flexion and the degree of abduction or adduction are then ascertained by the methods already described (p. 460), as the extension must at first be made as accurately as possible in the line of the abnormal position the limb has assumed. A long broad strip of adhesive plaster is then applied of sufficient length to reach from a few inches above the knee on each side of the limb, and to leave a loop projecting beyond the sole of the foot for about one foot. In the loop is placed a piece of wood three inches in length to form a spreader, and thus to prevent injurious pressure on the malleoli. A hole may be drilled through the spreader and the plaster covering it, and through this the cord bearing the weight is passed and secured by a knot. Narrower strips of plaster are then applied diagonally round the limb to fix the first piece more securely ; great care being taken that no strip passes circularly round the limb in such a way as to constrict it. A flannel bandage is then applied from the malleoli to the middle of the thigh, to ensure the adhesion of the plaster. A long splint is then applied to the *sound* limb; without this, although by extension the pain may be removed, adduction or abduction and some degree of flexion cannot be prevented, as the patient will turn on one side and avoid the direct pull of the weight. The long splint being fixed, the weight is applied to the rope attached to the spreader and passing over a pulley. The pulley should be fixed to some apparatus allowing of its being raised or lowered as circumstances may require. If the proper apparatus, such as is used in hospitals, be not at hand, a pulley may be readily made from a cotton-reel with a piece of wire passed through it, by which it can be slung to the back of a chair or a clothes-horse. The weight of the body serves as the counter-extension, and if necessary the foot of the bed may be raised on blocks to prevent the patient slipping down in the bed. The most convenient form of weight is a tin can filled with shot or water, till the degree of extension obtained is comfortable to the patient. The pulley and weight are to be adjusted in such a way that the extension shall act on the limb directly in the line of its abnormal position. To do this the diseased limb must be raised till the lumbar spine is in contact with the bed, and the degree of abduction or adduction must correspond to that noted before the apparatus was applied. During the acute stage any forced attempt to drag the limb immediately into its normal position would only aggravate the pain, but by making the extension as above described, it will be found that the limb speedily falls into the proper position. At the end of each day the pulley must be readjusted so as gradually to bring the limb parallel to its fellow. In recent cases a few days will often suffice to bring the limb into its normal position, in more advanced cases some weeks may be required. If the treatment has to be continued for any length of time, the apparatus represented in Fig. 592 may be employed. In it the pelvis and body are fixed to the bed by means of broad felt straps and buckles. A leather ankle-strap is then placed round the foot and lower part of the leg, and a padded belt above the knee. From the sides of each of these, straps are carried to a point six or eight inches beyond the foot, where they are attached to a transverse iron rod, four inches long. From this the cord suspend-

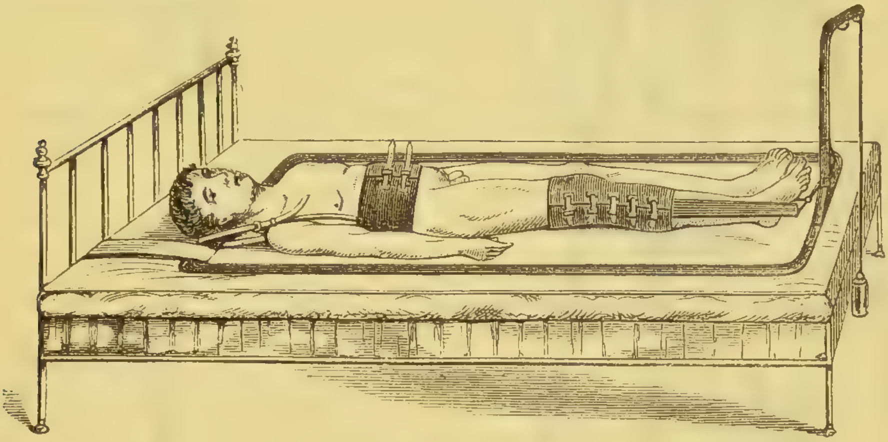


Fig. 592.—Apparatus for Extension by Weights in Hip-joint Disease.

ing the weight passes over a pulley-frame fixed to the end of the bed. The weight applied should be from two to three pounds in children up to six years of age ; four pounds between the ages of six and ten ; five or six pounds from ten to thirty.

If the long splint alone be used, it must be applied as for fractured thigh, the perineal band being dispensed with if it causes pain. The single long splint, though moderately efficient in adults, is of little use in children, as they always manage by twisting the body to maintain a considerable degree of flexion with adduction or abduction. Hamilton's double long splint (Fig. 236, Vol. I., p. 626) should therefore be used, by which a much better position is obtained. Weight-extension can be applied with this if required. When there is much adduction or abduction, the part of the splint corresponding to the hip-joint on the diseased side may be sawn through and fitted with a hinge, allowing of movement in the required direction, the lower end being at the same time loosened from the cross-bar ; the lateral displacement can then be corrected by means of india-rubber bands acting on the lower end of the splint from a nail or peg driven into the cross-bar.

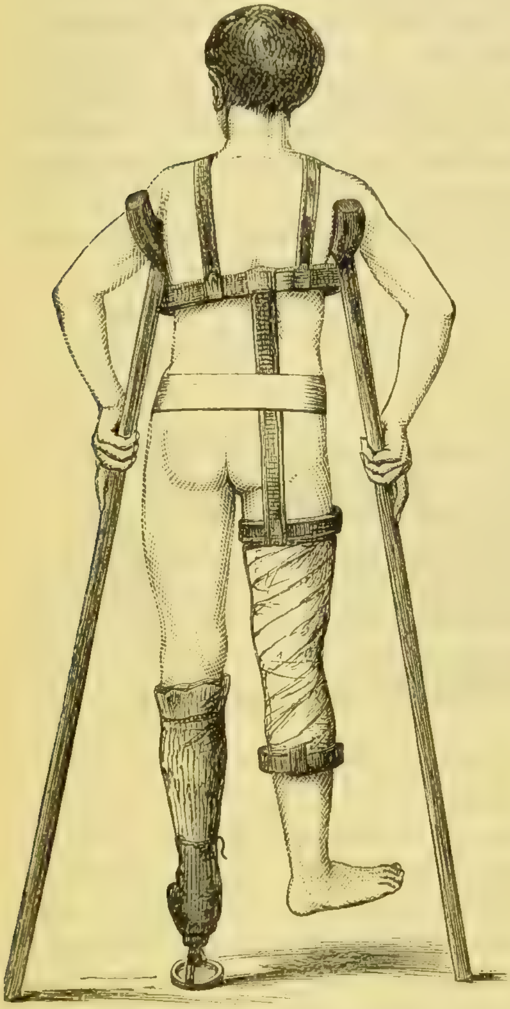


Fig. 593.—Thomas's Splint applied.

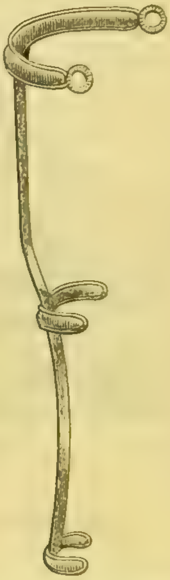


Fig. 594.—Thomas's Splint.

Thomas's splint (Figs. 593, 594) is by far the best apparatus ever invented for the treatment of all forms of hip-disease. It may be applied at any stage and should be worn till the cure is complete. It will, however, often be found most convenient when there is considerable abduction or adduction with acute pain in the early stages of the disease, to correct this by means of the weight-extension used as above described before applying the Thomas's splint. Thomas's splint is the only apparatus that maintains absolute rest of the joint, while at the same time the patient is able to move about during the whole or greater part of the treatment. The splint consists of a flat bar of soft iron, varying from three quarters of an inch to an inch and a half in width, and from three-sixteenths to three-eighths of an inch in thickness, according to the age, size, and weight of the patient. This bar must be long enough to reach from the lower angle of the scapula to the middle of the leg immediately below the prominence of the calf. The upper and lower parts must be straight to fit the back and the leg, and between these it must be bent into a curve accurately fitted to the buttock of the patient. To this vertical bar, three curved transverse bars of soft iron about $\frac{1}{8}$ inch thick, by 1 to $\frac{3}{4}$ inch, are fixed as in Fig. 594. The upper of these should be of sufficient length to embrace the chest about as far as the nipple on each side. The middle bar should be immediately below the curve for the buttock in the vertical bar. If it be placed too low, the splint is more apt to twist round and allow of flexion. The whole apparatus is padded with a thin layer of felt, or flannel, covered by leather. The splint is applied in such a way that the curved part of the vertical bar lies midway between the tuberosity of the ischium and the trochanter major. The curved parts are then bent so as to fit the chest, thigh, and leg comfortably. A strong piece of bandage is passed through the rings in the ends of the chest-piece, and tied firmly. A broad body-bandage of swan's-down calico, or flannel, is then wound round the vertical bar, so as to get a good hold of it, and then carried two or three times round the body. A narrower bandage is then applied to the thigh and leg. If the patient is to walk about, braces of strong calico must be fixed to the chest-piece, and carried over the shoulders, otherwise the splint will slip down. If there is much flexion, the splint may be bent forwards immediately below the buttock curve to a degree a little less than that of the limb, which may be allowed to lie upon it with the knee slightly bent. In this position it is secured by a few turns of bandage round the thigh and leg. In a few days, if the patient be kept on his back, the weight of the limb will have extended the hip, so that the whole leg is uniformly in contact with the splint, which may then be straightened a little ; and this is repeated until the flexion is corrected. The vertical bar must never be bent opposite the knee. If there is much adduction, it is often convenient to twist the vertical bar, so that its anterior aspect looks very slightly outwards from below the buttock. These alterations in the shape of the splint must be carried out by the Surgeon himself with strong iron wrenches made for the purpose. A little experience is required in the manipulation of these splints, but the necessary skill is easily acquired, and will well repay the Surgeon for the trouble involved in so doing. The splint must be worn continuously day and night till all symptoms have subsided, often for two or three years. In walking with crutches, the patient is raised by a patten on the foot of the sound limb, so that the opposite foot does not touch the ground (Fig. 593). Should suppuration take place, Thomas's splint is still the most convenient apparatus, as it leaves the parts uncovered in which the abscesses point. One great advantage in Thomas's splint, is that under the superintendence of the Surgeon, any common blacksmith can do the iron-work, and any saddler the padding, and it is thus equally available for country or city practice.

An ingenious extending apparatus for hip-joint disease has been invented by Sayre (see Fig. 595). By means of this instrument, extension is made from the thigh, and counter-extension from the pelvis, the apparatus being lengthened by a rack and pinion on the outer bar. It does not prevent movement of the joint, and is inferior to Thomas's splint in every way.

After all acute symptoms have disappeared, Thomas's splint is still the best apparatus, but sometimes the joint may be conveniently fixed by means of a leather splint, the starched bandage, or the plaster-of-Paris bandage. Of these I prefer the starched bandage as being more easily applied. The hip part must be strengthened with a piece of pasteboard lined with calico, sufficiently long to extend down the whole of the back of the thigh to below the knee, so as to support that joint also, and the spica bandage must be applied in repeated turns, otherwise the apparatus will not fix the joint. In applying this or any other apparatus, it is often necessary, especially in children, to administer chloroform, as the pain occasioned by the necessary movements may be too severe to be borne without it.

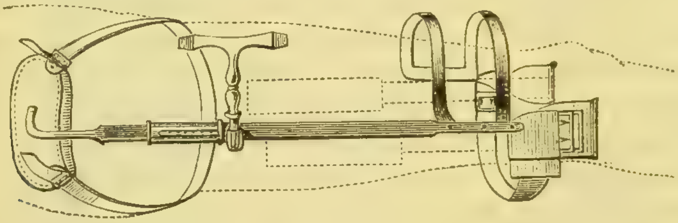


Fig. 595.—Sayre's Extending Apparatus for Hip-joint Disease.

When the disease has from the first been sub-acute, as is usually the case when it commences in the head of the femur, the same treatment must be pursued, but it may not be necessary at any time to confine the patient to bed, or to have resort to weight-extension.

The constitutional treatment must be conducted on those principles already laid down in the chapter on diseases of joints in general.

If *dislocation have taken place*, and the limb consequently have become a good deal shortened or deformed, being perhaps adducted and inverted so far as to be twisted over the other, or drawn up upon the abdomen, much may be done to lessen the deformity by putting the patient under chloroform, bringing down the limb, and fixing it by a proper splint. Ankylosis in a good position may thus be sometimes obtained, and the patient's condition be greatly improved. In cases of dislocation from tubercular disease of the hip, no attempt at reduction is justifiable, even if all acute symptoms have passed off. Not only would it be attended by great risk of starting fresh acute disease in the joint, and checking the natural processes of repair, but it could not possibly be successful, as the acetabulum would probably be filled up, the head of the bone altered in shape and size and the ligaments shortened. It is only in the so-called distension dislocations from acute effusion into the joint subsiding without suppuration that reduction could be attempted with any prospect of success (Vol. I., p. 660). If ankylosis be likely to occur, the Surgeon must endeavour to secure it with the limb in a straight position; otherwise great inconvenience to the patient may result, especially if it occur in the position represented in Fig. 603. After a stiff joint has formed, the mobility of the lumbar vertebræ, and more particularly of the lumbo-sacral articulation, will be found to be greatly increased: so that at last the patient will walk with little inconvenience. If the ankylosis be not osseous, but the result of the *arthritic* form of the disease, and especially if the head of the bone be still in the acetabulum, the limb may be straightened by forcible extension and rotation under chloroform, and the heel thus brought to the ground.

When once *suppuration has taken place* the sooner the pus is evacuated the better. No good can possibly come from the retention of pus in the joint. It leads only to further disorganization of the articular structures, to continued constitutional irritation, and at length to bursting of the capsule, and the formation of large extra-articular abscesses. To Annandale we are indebted for having put this practice to the test of experience, and, by making a free incision into the posterior part of the joint, in conjunction with antiseptics and good drainage, obtaining the most satisfactory results.

It is only in very acute cases, however, that this treatment can be practised; more commonly suppuration takes place slowly, and is not recognized till a considerable extra-articular abscess has formed. Such abscesses should be opened early and freely, and with antiseptic precautions. At the time the abscess is opened the cavity must be thoroughly examined with the finger to search for sequestra, and to ascertain if possible the situation of the disease, the position and size of the opening in the capsule, and the condition of the head of the bone.

EXCISION OF THE HEAD OF THE THIGH-BONE AND OF THE HIP-JOINT.

White of Manchester, in 1769, was the first to propose, and Anthony White, of the Westminster Hospital, in 1821, was the first to perform, excision of the head of the femur. This he did on a boy eight years old, who had had disease of the hip-joint for three or four years, and in whom the carious head of the thigh-bone rested on the dorsum ilii. White removed the head and trochanters of the bone, and the patient recovered from the operation, dying of phthisis five years afterwards. The preparation is in the Museum of the College of Surgeons. This operation was repeated by Hewson of Dublin, in 1823; and then seems to have been forgotten in Great Britain until its revival, in 1845, by Fergusson. But in the meanwhile it had not entirely escaped the attention of Continental Surgeons. Oppenheim, in 1829, and Seutin, in 1832, excised the head of the femur for gunshot injury; and, in 1842, Textor published an essay on the subject.

Cases requiring Operation.—Diseases of and about the hip-joint may, so far as the question of operation is concerned, be divided into two great classes—those in which no suppuration takes place, however acute the inflammation may have been; and those in which abscess forms.

In the first class the patient commonly recovers with a stiffened or even completely ankylosed, though useful and straight limb, dislocation of the head of the bone not having occurred. In such cases excision is never needed.

The second class of cases—those in which abscess forms—is by far the more numerous. In the great majority, however, the head of the femur is the part primarily affected, and in these recovery will take place eventually, under properly conducted medico-surgical treatment. But the recovery in such cases is always so far incomplete that the limb is left much crippled, and often of but little utility. After years of suffering and confinement to bed, and after a hard struggle for existence, we find the unfortunate patient left eventually with a limb that is shortened to the extent of from two to four inches, wasted and adducted, with a projecting deformed hip seamed with cicatrices; the remains of the head of the femur being dislocated from the acetabulum, and firmly adherent to the dorsum ilii. The limb is unable to support the body, and cannot be extended, nor can the sole of the foot be firmly planted on the ground; but the leg is to a certain extent useful in progression, the patient using it as a kind of paddle to push himself on with, as he limps on the point of the toes. In these cases it is interesting to observe how nature compensates for the loss of all abduction and rotatory power in the hip by giving an extremely increased degree of mobility to the lumbar vertebræ; so that the patient, in walking, swings the pelvis from these, and thus in a great degree makes up for the loss of the natural movements in the ilio-femoral articulation.

But though recovery takes place eventually in many cases of coxalgia that have advanced to suppuration, yet in a considerable proportion the patient's constitution becomes unequal to the drain imposed upon it, and fatal hectic supervenes. This is the direct consequence of the wasting and exhausting influence of the long-continued discharge of pus from around masses of carious or necrosed bone, too extensive or too deeply seated to be eliminated by natural processes. It is in such cases as these that conservative surgery steps in, and endeavours to save the patient's life by the removal of the cause that keeps up the discharge which is wasting it away. The object here is simply to save life by the removal of diseased bone. For the same reason—the prevention of death from hectic—that the Surgeon amputates in an extreme case of suppurating disorganization of the knee-joint, he excises in disease of the hip-joint: amputation is here too formidable a proceeding to be undertaken except in the last extremity, and yet the removal of the diseased bone, the irritation and suppuration from which are rapidly destroying the patient, is an imperative necessity.

Femoral coxalgia is the form of the disease that is most benefited by operation. In severe cases of this variety, the upper epiphysis of the thigh-bone will be found lying in a state of caries on the dorsum ilii, in a suppurating cavity, with sinuses leading down to it. The pelvic bones are sound; the acetabulum is filled by fibrous tissue, though possibly it may be slightly roughened and necrosed at one lip. The soft structures in the gluteal region are thinned and wasted; the limb is shortened and adducted. In such cases as these, the patient will probably perish if left to the unaided efforts of nature; or if he recover, after years of suffering, it will be with a limb shortened, deformed, and but little useful. Resection, being limited to the upper end of the thigh-bone, or at most to the roughened lip of the acetabulum as well, is an easy operation, removes the cause of the wasting discharges and hectic, and in no way increases the already existing shortening, as it is limited to that portion of diseased bone which is already lying above and behind the acetabulum, and which is affected by caries of too extensive and deep-seated a character to disintegrate and crumble away in the discharges, so that a natural cure without operation could take place.

In the acetabular pelvic form of coxalgia, the ultimate result is, I believe, inevitably fatal, if the disease be allowed to run its course unchecked by operation. Large portions of the pelvic bones in and around the acetabulum—such as the tuber and ramus of the ischium, the ramus of the pubes and the dorsum ilii—fall into a state of necrosis; the cavity becomes perforated (Fig. 596); and the head of the thigh-bone, still lying in it, becomes denuded of its cartilaginous investment, roughened and carious, as is well seen in the annexed drawing (Fig. 597), taken from a patient of mine who died of this form of the disease; or it may be dislocated in a carious state on to the dorsum ilii. Large abscesses, intra- as well as extra-pelvic, form, and the patient dies worn out by hectic; the natural efforts of the part being entirely unavailing to separate and to eliminate such large necrosed masses, deeply lying, and covered in by the upper end of the thigh-bone.

Excision is imperatively required also in those cases in which the acetabulum has been perforated secondarily, in consequence of disease commencing in the head of the femur, as by no other means can the intra-pelvic abscess which results be efficiently drained. It is not enough then to remove the head of the femur only; the bone must be sawn below the trochanter, otherwise the upper end of the femur will still interfere with drainage.

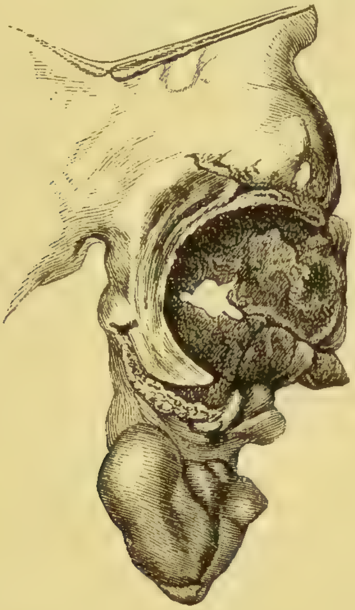


Fig. 596.—Perforation of the Pelvic Bones in Acetabular Coxalgia.

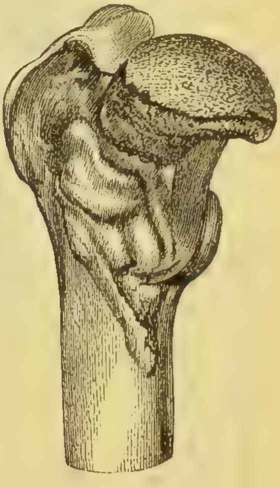


Fig. 597.—Carious Head of Thigh-bone in Acetabular Coxalgia.

The **stage of the disease most suitable for operation** has been the subject of much discussion. Formerly the operation was only undertaken as a last resource, and its mortality was undoubtedly very high chiefly from pyæmia, septicæmia, and exhaustion from profuse suppuration. Since the modern improvements in the treatment of wounds have to a great extent removed these sources of danger, it has been suggested by Annandale, Croft, and others that the operation might advantageously be had recourse to at an earlier stage of the disease. In all cases in which signs of suppuration are present, they recommend that an antiseptic exploratory incision be made into the joint, and the head of the femur examined;—if found diseased, it should be removed by sawing through its neck. Should there be osseous disease beyond this in the acetabulum or in the femur, it must be cut away. Annandale is led to recommend early operation of the kind mentioned in those cases of hip-disease in which signs of suppuration exist, by the consideration that the head of the femur is usually carious in these cases, and that its early removal is likely to check the further progress of the disease, and to leave the patient with a useful and movable limb. Against early excision it is urged that a considerable number of cases recover after suppuration without the removal of bone, and that when this occurs the limb is more useful than that left after operation. The table given on p. 470, however, shows that without operation the cures and deaths are about equal in number, so that the prospect of conservative treatment is not very encouraging after pus has formed; and there is little doubt that the earlier the operation of excision is performed, the less bone as a rule will require removal, and the more useful will the limb be subsequently. Moreover, free incision directly on the joint will be found the most satisfactory method of treating an abscess communicating with its cavity, even if it point at some distance from the articulation. The joint being thus exposed, it would seem the wiser plan to examine the bones, and if much disease is found to proceed immediately to excision.

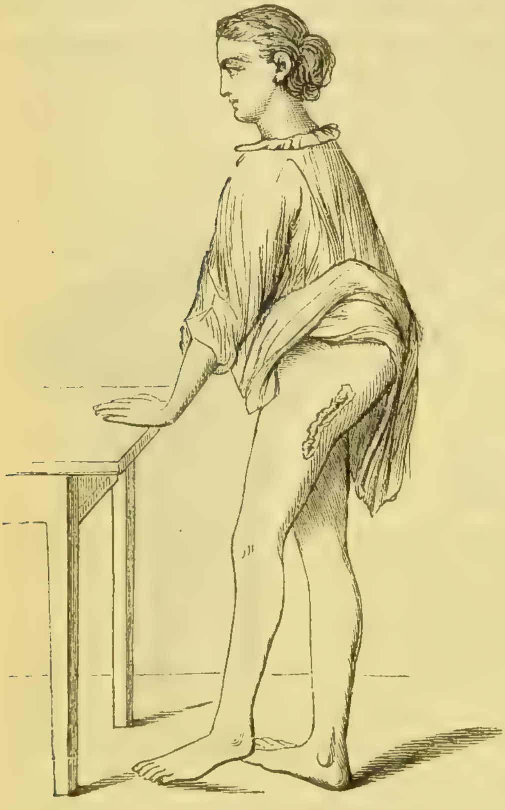


Fig. 598.—Result of Excision for Extensive Acetabular Coxalgia, three years after Operation.

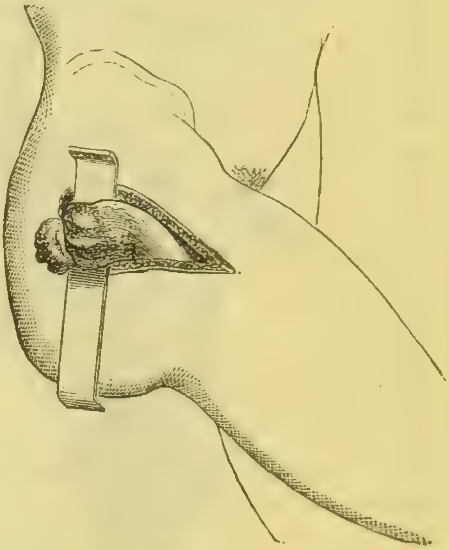


Fig. 599.—Excision in Femoral Coxalgia.

Early excision is required also in those cases in which the head of the femur is necrosed. This condition is not easy to recognize, except by digital examination of the articulation through the wound made in opening the abscess. It may be suspected to be present when the symptoms have set in with great acuteness, and have rapidly reached the stage of suppuration, this form of hip-disease being not unfrequently due to acute osteomyelitis of the epiphysis of the head or acute epiphysitis. If the sequestrum is loose it may be removed in some cases without any further portion of the bone. If it is still attached, the neck may be sawn through, and the head alone taken away.

When dislocation takes place early, before the head has been extensively destroyed, giving rise to very marked flexion, adduction and rotation inwards, excision of the bone is often the only means by which the limb can be brought into good position, and in such cases it may be undertaken at an early period.

Methods of Operating.—From the preceding considerations, it will be observed that there are two distinct operations practised on the hip-joint. The first is simple resection of a portion of the upper end of the femur, and the second, the removal of more or less of the acetabulum, and of the contiguous pelvic bones as well. For the removal of the upper end of the femur only, the following plans may be adopted. The operation may, in most cases, be performed bloodlessly by applying the india-rubber tourniquet in the same way as for amputation of the hip-joint (Vol. I., Fig. 9). The advantages gained by so doing are very great, as it enables the Surgeon to ascertain the condition of the trochanter and upper end of the femur with great accuracy. The patient is then placed on the sound side. If the disease be femoral, the gluteal region perforated with sinuses, and the soft parts thinned, the head of the bone lying dislocated on the dorsum ilii, it suffices to pass a director down one of the chief sinuses leading to the carious bone, and to slit this up. If, however, the bone be more thickly covered, and be not easily reached with the probe, and if the sinuses open on the thigh at some considerable distance from the seat of disease, then a T-shaped incision may be made over the upper end of the thigh-bone, so as to expose it (Fig. 599). The limb should now be adducted, rotated inwards, and pushed upwards by an assistant, and the soft structures separated by a probe-pointed knife or the periosteal elevator from around the upper end of the bone, so that the whole amount of disease may come into view. The upper end of the femur is then cut off with a saw, the soft parts around being protected by means of retractors.

There is one practical question which requires consideration. Should the bone be sawn through below the great trochanter or through the neck only, leaving the trochanter? In early excision if the trochanter is apparently healthy it may be left, as in this way the attachment of the ilio-femoral ligament may be preserved and a more useful limb ensured ; but the cases in which it can be saved with advantage are exceptional. In late excision, if the head of the bone is extensively diseased, the great trochanter should be removed, as it is very likely to be infiltrated with tubercle. If the acetabulum is extensively affected, more especially if it is perforated, and if the bones of the pelvis are widely diseased, the whole upper end of the femur must be removed to ensure efficient drainage. In such cases our first object is to save life, and the utility of the limb is a secondary consideration.

After removing the head of the bone the upper end of the shaft should be examined, and any carious parts gouged out. The acetabulum must then be examined, and any rough or necrosed bone lying at its edge should be gouged away.

In cases in which the situation and extent of the sinuses leave the Surgeon a free choice for the situation of his incision, the plan recommended by Sayre will be found to give excellent results. A semilunar incision is made with its concavity forwards, commencing above the trochanter major midway between it and the crest of the ilium and carried downwards behind the bone. The first incision must go directly down to the bone through the periosteum. The soft parts are then pulled forwards, and the periosteum divided by means of a small but strong curved bistoury as far as possible round the bone below the trochanter, in a direction at right angles to the lower part of the first incision. The Surgeon then peels the periosteum with the muscles attached to the trochanter off the bone with a strong periosteal elevator. The joint is then thoroughly opened, and the head of the bone turned out, by which the periosteum is peeled off from the inner side ; lastly, the bone is sawn through above the trochanter minor. By saving the periosteum, Sayre states that he obtains more perfect repair with less shortening, and a stronger and more movable joint.

In some cases the head of the femur may be very conveniently excised by an anterior incision, as recommended by R. W. Parker. The incision should be carried through the interval between the tensor vaginæ femoris and the sartorius. The finger being introduced into the wound passes directly backwards past the anterior border of the gluteus medius and gluteus minimus, and external to the head of the rectus, and thus reaches the neck of the femur. As this is the direction taken by the abscess in a large proportion of cases, no cutting is required after the interval between the sartorius and the tensor vaginæ has been opened. The neck of the bone may then be sawn through with an Adams's saw (Fig. 607), and the head removed with sequestrum forceps. This method is adapted to those cases only in which the head of the bone is alone diseased, and it is not necessary to remove the trochanter, and more especially to those in which an abscess is pointing in the situation of the incision. Experience has shown that the wound drains fairly well in most cases, but should there be any accumulation of discharges, an opening can be made behind and a drainage-tube inserted, the anterior wound being allowed to close. No muscles or other important structures are divided in the operation. It should never be attempted when the acetabulum is perforated, as it does not provide efficient drainage for an intra-pelvic abscess, and

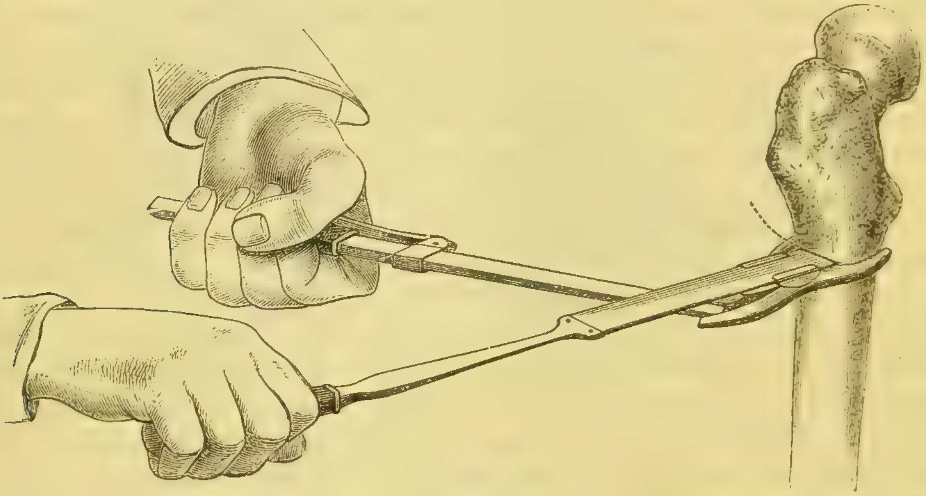


Fig. 600.—Gowan's Osteotome.

it is not advisable when the head is considerably displaced backwards on the dorsum ilii.

In sawing the bone in excision of the hip, the ingenious instrument invented by Gowan of Guy's Hospital will be found very useful in some cases (Fig. 600).

Removal of Diseased Acetabulum and Pelvic Bones.—Until a comparatively recent period, Surgeons feared to undertake the removal of large carious and necrosed portions of the pelvic bones, and acetabular disease of the hip-joint was accordingly allowed to run its fatal course unchecked. Hancock was the first Surgeon who undertook the removal of large portions of these bones, and since then the operation has been done several times by others. In no case, has, I believe, more extensive disease been removed with a good result than in a girl who was sent to me some years ago by my friend Mr. Tweed, and from whom I removed the upper end of the thigh-bone, the acetabulum, the rami of the pubes and of the ischium, a portion of the tuber ischii, and part of the dorsum ilii. This patient, when admitted into the Hospital, was in the last stage of disease, exhausted by constant discharge, and must inevitably have speedily sunk had no effort been made to remove the cause of the prostration. At the operation she was so exhausted that it was necessary to leave her on the operating-table for some hours before she was sufficiently restored to bear moving into bed. Nevertheless, by the free use of stimulants and nourishing food, she improved rapidly; and when she recovered, the limb presented the appearance in the drawing (Fig. 598); it was straight, shortened about two inches; good movement existed at the hip; and she could walk with much ease. Constitutionally, she was in perfect health, and has continued so up to the time when she was last seen, about fourteen years after the operation. In three other cases I have successfully removed large portions of the acetabulum and of the contiguous portions of the ilium and ischium. In cases such as these, the result, if they are left to themselves, must inevitably be fatal. There is no danger of laying open the pelvic cavity during the removal of these masses of pelvic bone; for, as Hancock has shown, during the progress of the disease the fasciæ, muscles, &c., lining the pelvis, become so thickened that they form a barrier which effectually protects the pelvic cavity.

Where large portions of the pelvic bones require removal, the early stages of the operation require to be conducted in the way first described; the incisions, however, being made more freely, but not carried so far forwards as to endanger the anterior crural, or so far back as to wound the sciatic nerve. After the removal of the head of the thigh-bone, all loose necrosed pieces are to be taken out, and then, by means of ordinary cutting or gouge-forceps, the acetabulum and other carious osseous structures are cut away piecemeal. Those portions of bone which have necrosed are usually lying loose, or else may generally be readily separated by the finger, or by the handle of a scalpel, from the subjacent soft structures; and the muscles and fasciæ lining the pelvic bones, being thickened and infiltrated with inflammatory products, protect the contained parts from all injury.

Excision of the hip should be performed with antiseptic precautions when possible. If foul sinuses exist these may be scraped with a sharp spoon, and cleaned with a small sponge dipped in a solution of chloride of zinc, and held in a pair of sinus-forceps. Some simple antiseptic dressing may then be applied, and the limb fixed with a bracketed long splint. In many cases no splint is required, the simple weight-extension apparatus (p. 473) keeping the limb in good position. A double Thomas's splint with the piece opposite the wound cut out, and cross bars above and below the gap will be found very useful in young children.

Fergusson recommends that the extension should be made from the opposite thigh, round the upper part of which a socket is fixed, to which the band is attached (Fig. 601). Much advantage will be derived from the use of the bracketed thigh-splint, from which extension may be made by means of a weight. When the wound has partly healed, if the situation of the incision allows of it, a Thomas's hip-splint may be applied and the patient allowed to move about.

Results.—The result of excision of the hip-joint has to be considered from two points of view:—1. As to the Mortality immediately referable to the operation; and 2. As to the Utility of the Limb that is left after its performance.

1. *Mortality after the Operation.*—Sayre of New York, in 1860, collected the statistics of 109 cases; of these, recovery took place in 71, 36 died, and in 2 the result is noted as being unsatisfactory. Leisrink of Hamburg has published in the *Archiv für Klinische Chirurgie* (1870) the statistics of 176 cases. In 24 of these, or 13·6 per cent., death occurred from intercurrent diseases—mostly pyæmia (11) and septicæmia (2). Fourteen patients, or 8 per cent., died within a fortnight from exhaustion; 14 others died between this time and the end of the first month—most from exhaustion, one from amyloid disease, and two from phthisis. From the beginning of the second month to the end of the year after the operation there were 27 deaths, or 15·3 per cent.; while nine died in the course of two or more years, of phthisis and other diseases. Leisrink states that in 176 cases of excision of the hip, there were altogether 98 deaths. Of this apparently high mortality, however, only about one half, or 26 per cent. of the whole cases, can be ascribed to the operation itself, or to pyæmia and other diseases which are liable to attend operative procedures. The other half of the deaths were produced by extension of the disease, by diarrhœa, or by phthisis or other disease of internal organs—probably in many instances existing at the time when the operation was performed.

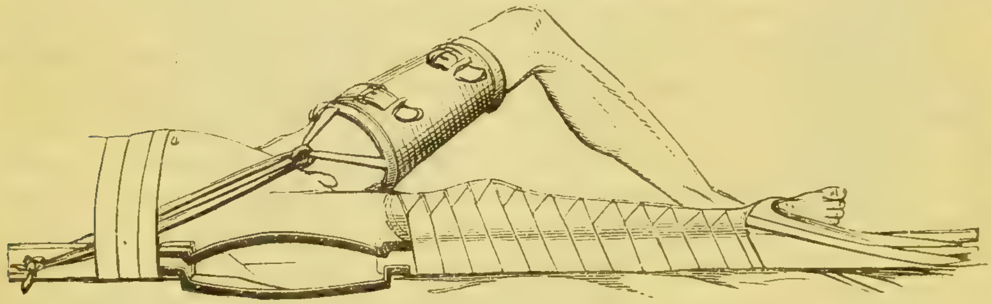


Fig. 601.—Apparatus to be used after Excision of Hip-joint.

The mortality following the operation appears to have been much lower in England and America than in France and Germany. In 1881 Croft published the statistics of 45 cases operated on by himself; of these 19 recovered, 18 died, and 8 were still under treatment at the time of the report. Of the 40 per cent. of deaths, 15·6 died directly from the operation, 13·4 from some form of tubercular disease, 6·6 from albuminoid disease, and 4·4 from causes unconnected with the joint-affection. Of 203 cases of excision collected by the Committee of the Clinical Society, 29, or 13·7 per cent. died directly from the operation.

The result of my own experience is, that the mortality directly referable to the operation itself is but small. Excision of the head of the thigh-bone or of the hip-joint stands in a different position from similar operations practised on other joints. The Surgeon excises the elbow, shoulder, or ankle, in order to restore a useful limb to the patient. Excision of these joints is a substitute for the loss of the limb by amputation—not, as in most cases of excision of the hip, to prevent the almost inevitable loss of the life of the patient by continuance of hectic.

2. In estimating the *utility of the limb left after the excision of the hip-joint*, we must compare it with the kind of member that would be left in the event of the patient surviving sufficiently long for a natural cure to result. It would be manifestly absurd to compare a limb which had become seriously crippled, withered, diseased, and shortened, before any operation was undertaken, with one in which no morbid process had ever taken place. So also would it be unjust to compare it with the state of a limb left after a slight attack of coxalgia, in which operation could never have become necessary, nor have been contemplated. But, on comparing the results of cases operated on with those of cases which recover spontaneously, after caries of the upper epiphysis of the thigh-bone has existed for years, we shall find that the balance is by no means against those in which excision has been done. As I do not consider the operation necessary in *arthritic* coxalgia, I do not compare the result of these cases with that of those operated on, but confine myself entirely to those in which there has been destructive bone-disease. In those cases of this description, when, after years of prolonged suffering, recovery is at last accomplished by natural means, the limb left is more or less completely ankylosed at the hip, wasted, shortened to the extent of two to four inches, partially flexed upon the pelvis, adducted, with the knee possibly stiffened, semiflexed and advanced; the patient is just able to put the toes to the ground, without the power of bearing upon or rotating the limb, but, when he wishes to turn, twisting the whole pelvis by the aid of the greatly increased mobility of the lumbar spine.

After successful excision, the result is much more satisfactory, as may be seen in Fig. 598. The principal abnormal appearance in the limb is its shortening, to the extent usually of from two to three inches—to the extent, indeed, to which the pre-existing disorganization and dislocation of the head of the bone had previously reduced it. It is well-nourished, straight, firm, and allows easy and rapid progression. The ankylosis is fibrous, not osseous. The patient is thus enabled to flex the thigh on the pelvis, and to adduct it; but, just as in cases that have undergone a natural cure, the power of external rotation and of abduction is lost, the mobility of the lumbar spine compensating for the loss of these movements.

Disease of the Great Trochanter occasionally occurs with abscess in the upper and outer part of the thigh, at first sight closely resembling hip-disease; but a little careful examination with the probe and by manipulation of the limb, will soon convince the Surgeon that the joint is free from disease, and that the morbid process is limited to the trochanter, and possibly the root of the neck of the thigh-bone. Disease of the trochanter is more common in children, but is occasionally met with in adults. The most common pathological condition met with is necrosis either central or superficial. In children this may be the result of injury or of acute osteomyelitis of the epiphysis of the trochanter. Tubercular caries, often accompanied by necrosis (caries necrotica) sometimes occurs also in this epiphysis just as in that of the head of the bone. In these cases the limb should be made bloodless, and the trochanter freely exposed by a curved incision (Fig. 602). Sequestra may then be removed, or the diseased osseous structures gouged away. In such operations I have not only successfully removed the greater part of the trochanter, but have scooped out even a portion of the interior of the carious neck of the thigh-bone at its trochanteric end ; thus preventing the inevitable disorganization of the hip-joint which would have resulted if the diseased bone had been allowed to remain in close proximity to the articulation. In this operation the Surgeon necessarily comes into very close proximity with the capsule of the joint; and unless great care be taken this may be opened, and thus the very mischief induced which the operation is undertaken to prevent. Should the disease be found to be so extensive that it becomes necessary to excise the joint, this can be easily done without extending the incision.

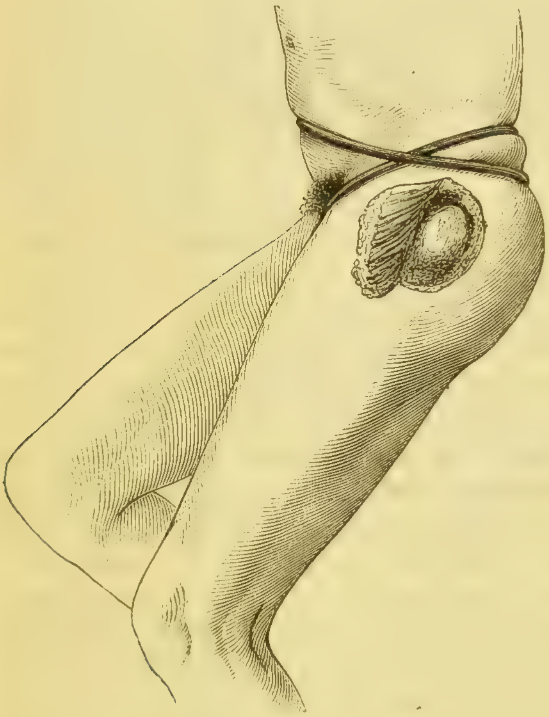


Fig. 602.—Incision exposing the Great Trochanter for the removal of diseased bone. Esmarch's bandage applied to render the operation bloodless.

Amputation in Cases of Disease of the Hip-joint.—The question of amputation in cases of disease of the hip-joint is one that must often have presented itself to the Surgeon when he has contemplated the shortened, wasted, and deformed member that is frequently left after the more advanced forms of the disease, and which can never be rendered useful as a basis of support to the body by any mechanical contrivance, however skilfully designed, but must always remain not only a useless but a cumbrous appendage.

It appears to me that in the more advanced chronic cases of hip-joint disease, this operation is justifiable, and, indeed, is to be advocated in certain circumstances. These are as follows :

1. In cases where the disease is confined to the head of the femur, or where, if any portion of the pelvic bones be attacked, it is to so limited an extent as to be readily removable by the gouge, excision would necessarily be the usual practice. But if the patient's health be too low to bear this, or if the limb be so shortened, atrophied, and deformed by long disuse as to be incapable of furnishing proper support, then amputation at the hip-joint would, I think, be a proper procedure. I do not think that the mere destruc-

tion of the cartilaginous lining of the acetabulum should militate against the performance of the operation ; for we constantly see in hip-joint disease when the head of the bone has been dislocated, or after amputation at the hip-joint for accident or ordinary disease, that the acetabulum fills up with a dense fibroid mass after the destruction or removal of its cartilage. But, if the pelvic bones be so far diseased that the necrosed or carious part does not admit of removal, then necessarily amputation would not be justifiable.

2. When the disease involves the shaft of the femur, which may be necrosed, or atrophied to such an extent as not to leave a sound limb after the removal of the upper epiphysis, amputation would be proper.

3. Amputation would be justifiable after excision has been tried and has failed in securing a useful result to the patient, the limb being left short, weak, loose, and œdematous.

4. In a few instances amputation has been successfully performed when, after excision, the discharge from the sinuses had continued and albuminoid degeneration of the viscera had set in. Cases have been recorded by Marshall and Barwell, in which, after the operation, the size of the enlarged viscera sensibly diminished, and the general health greatly improved.

5. Excision of the hip is occasionally followed by osteo-myelitis of the femur, and acute necrosis of the shaft. Should the patient survive till the process becomes chronic, amputation affords the only chance of life. The operation was successfully performed under these circumstances a few years ago in University College Hospital.

ANKYLOSIS OF THE HIP-JOINT.

Ankylosis of the Hip-joint, following its inflammation, differs in its degree of completeness and in the position of the limb. Thus, it may be fibrous or osseous ; or the limb in either of these cases may be straight, or more or less flexed on the abdomen or adducted.

The most important point in these cases is the *direction of the limb.* When the head of the bone is completely ankylosed with the limb fully extended and straight, the osseous structures of the head of the femur and of the acetabulum being fused together, nothing can be done to improve the patient's condition. The lumbar spine will acquire increased mobility, especially in a rotatory direction, and the patient will stand and walk with ease. The chief difficulty arising from the position of the limb will occur in mounting stairs and in sitting.

If, however, the ankylosis be fibrous, even though the limb be straight, the freedom of movement may be much increased, and any faulty direction as to abduction or adduction may be in a great measure remedied, by douches, friction, pressure, or even forcible movement, and occasionally by the subcutaneous section of tense bands of fascia, or of tendinous and muscular structures about the anterior superior spine of the ilium.

If, unfortunately, the limb have become ankylosed in the flexed or angular position, means must be adopted to straighten it ; and this must be done whether the ankylosis be fibrous or osseous. For here the deformity and inutility of the limb are always considerable ; and increasingly so, the more the ankylosis approaches to a right angle.

In rectangular ankylosis of the hip, the foot cannot be put to the ground so long as the spine is straight (Fig. 603). In order that the toe should touch the ground, it becomes necessary that the body be bent forward; and the lumbar spine will consequently be thrown into a very considerable arch (Fig. 604).

The extent of the angular deformity in this kind of ankylosis can always be easily measured in the following way. If the patient be laid flat upon his back, so that the lumbar spine touches the mattress on which he is lying, the knee will be raised above that of the sound limb, and the angle formed between the thigh and trunk will be at once very perceptible. But if the knee be depressed so as to be brought to the same level as that of the sound limb, then the anterior superior spine of the ilium is rotated forwards, and the lumbar spine arched forwards to an extent proportionate to the angle of deformity.

This angular ankylosis of the hip-joint requires to be corrected, and the limb to be brought into a straight position, so that, even if it be shortened, the patient may, by means of a high-heeled boot, rest it upon the ground, and use it as a means of support and of progression. This may usually be effected without much difficulty, when the ankylosis is fibrous, by forcible extension under chloroform, the limb being thus often brought straight at once without any material difficulty. But in other cases this cannot be done by simple extension, resistance being offered by the muscles on the anterior and upper part of the thigh. In such circumstances, those that offer most resistance must be divided subcutaneously; and these will usually be found to be the rectus, tensor vaginæ femoris, pectineus, and gracilis. After the limb has, in this way, been straightened, and maintained for some time in the straight position by means of the long splint or weight apparatus or Thomas's splint, passive motion and frictions may be used to restore the mobility of the joint.

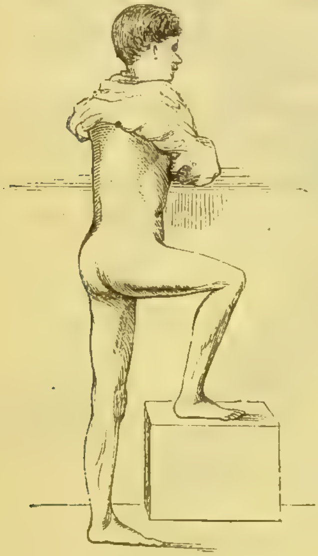


Fig. 603.—Ankylosis after Hip-joint Disease: Flexion of Limb on Pelvis.

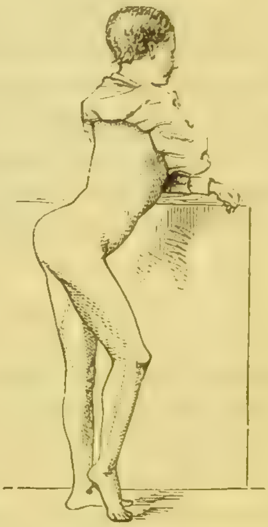


Fig. 604.—Ankylosis after Hip-joint Disease: Curvature of Spine in placing Foot on Ground.

Operation for Osseous Angular Ankylosis.—When osseous ankylosis of the hip has occurred in the flexed position, the case necessarily becomes much more serious; and the rectification of the position of the limb, and the restoration of its mobility, can be effected only by division of the Upper Part of the Femur; through its neck, if any remains of that structure still exist, or, at all events, above the trochanter minor.

The first operation of the kind was performed by Rhea Barton, in 1826. It was done in the case of a sailor, 21 years of age, who, in consequence of an injury, had an osseous ankylosis of the hip in a nearly rectangular position. Barton, according to Gross, made a crucial incision over and down to the great trochanter. The muscles were detached and turned aside, and the bone sawn through, the great trochanter and part of the neck of the femur being divided transversely. Whether a simple section of the bone was made, or, in conformity with Barton's usual practice in ankylosis, a V-shaped piece of bone was removed, I know not; for on this point American authorities differ. But the limb was brought into a straight position, and put up in a fracture-apparatus for twenty days. At the end of this time, passive motion was commenced, and at the end of four months the patient had a movable false joint, so that he could rotate the limb, abduct it for twenty inches, and carry it backwards and forwards to a still greater extent. The case was therefore eminently successful. The operation appears, however, to have attracted but little notice, and to have been but rarely followed by others. It is true that Barton himself operated a second time; and that Rogers of New York, in 1830, did so successfully on a man 47 years old. The example of these American Surgeons was followed in Europe, by Textor in 1841, and by Maisonneuve in 1847, on a girl of 18, successfully. Ross (U. S. A.) operated in 1857, on a woman of 23. In the two latter cases no false joint was made; but the bone, after being straightened, united again by callus. In March, 1869, I performed a similar operation at University College Hospital, on a girl of 16, who had rectangular osseous ankylosis of the right hip-joint. The patient made a slow but a good recovery with a straight and useful limb. There was no attempt at the formation of a false joint, but consolidation took place at the line of section.

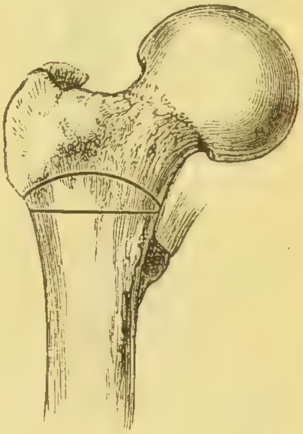


Fig. 605.—Lines of Section in Sayre's Operation for Ankylosis of Hip-joint.

The operation, having a double object in view, viz., the rectification of the position of the limb, and the establishment of a mobile false joint near to the obliterated ilio-femoral articulation, was thus shown to be practicable; yet it scarcely took a place in surgical practice, until Sayre of New York, in 1862, by performing it in two cases successfully, brought it prominently before the Profession. Sayre is undoubtedly entitled to the great merit of having established the operation on a distinct principle. His object was twofold; first, to go *above* the trochanter minor in the section of the bone, so as to retain the attachment of the psoas and iliacus muscles to the shaft for the purpose of flexion; and secondly, by cutting out a semicircular piece of bone, with its convexity upwards, and then rounding off the upper end of the lower fragment, more nearly to imitate the natural shape of the joint, for the purposes of motion and to prevent slipping of the bones. The accompanying Fig. 605, shows the situation and shape of Sayre's section, and of the piece of bone that he removes. The transverse section of the bone is first effected by means of the chain saw (Fig. 606); the convex one next by a narrow bladed saw.

W. Adams has devised a much more simple operation, having in view the same objects. His plan is to divide the neck of the thigh-bone *subcutaneously* about its centre. This idea he put in practice in December, 1869, when he performed the first subcutaneous section of the neck of the femur for the relief of deformity resulting from angular ankylosis. This operation is done as follows. A tenotome, having been introduced a little above the top of the great trochanter, is carried straight down to the neck of the femur, dividing the muscles and opening the capsule freely. The knife being withdrawn, a saw of this size (Fig. 607), set in a strong handle, is passed down to the bone, which is cut through from before backwards (Fig. 608). The section of the bone takes a few minutes, and is as much an act of filing as of

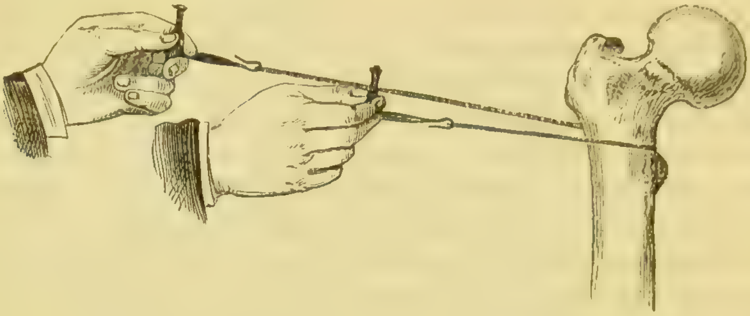


Fig. 606.—Application of Chain Saw in Sayre's Operation.

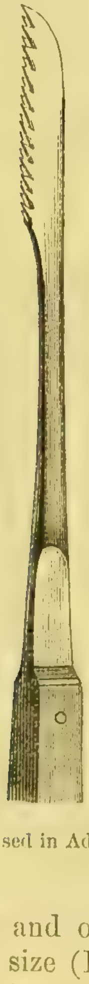


Fig. 607.—Saw used in Adams's Operation.

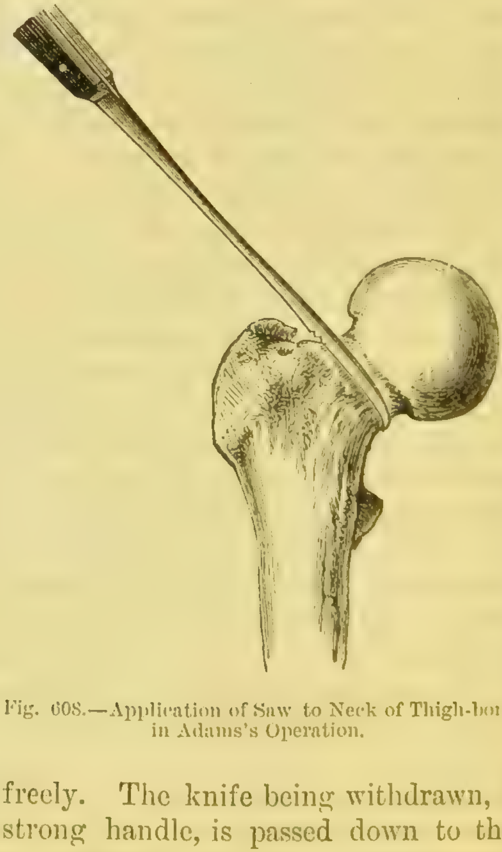


Fig. 608.—Application of Saw to Neck of Thigh-bone in Adams's Operation.

sawing. The wound is then closed by a pad, and the limb brought straight, Before this could be done in Adams's first case, it was necessary to divide the long head of the rectus, the adductor longus, and the tensor vaginæ femoris muscles. In performing this operation, as Adams justly observes, it is of great importance for the Surgeon to bear in mind the altered direction of the shaft of the femur, which is usually adducted as well as flexed forwards, so that the division of the neck may be made at right angles to the axis of the bone and not obliquely, or in a direction more or less parallel to the shaft. After the operation in Adams's first case, an endeavour was made by passive motion to get a false joint; but this being unsuccessful, the attempt was abandoned, and the limb allowed to ankylose in the straight position. Since this case, the operation has been repeated successfully by Adams and by many other Surgeons. Maunder preferred a chisel to the saw in practising osteotomy of the neck of the femur, and had much success in the operation so performed.

On comparing this operation with those which had preceded it, by Barton, Sayre, and others, there can be no doubt of its superior simplicity and safety; and although it is perhaps less likely to be followed by mobility of limb than when a piece of bone is cut out by Sayre's method, yet it must be admitted that not only is a movable false joint of doubtful utility, but it seems to have been very difficult of establishment, so great is the tendency to bony union after these sections.

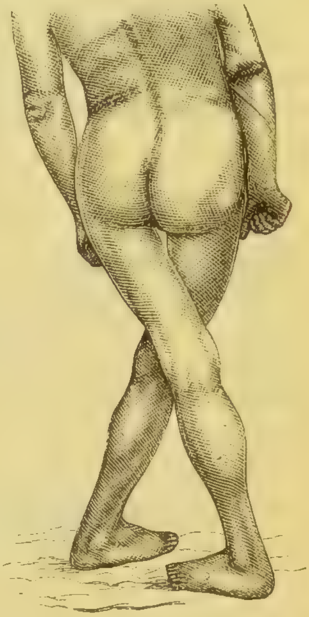


Fig. 609.—Cross-legged Deformity. Lucas's case.

Cross- or Scissor-legged Deformity is occasionally met with as the result of ankylosis of both hip-joints. (Fig. 609), which Clement Lucas has allowed me to take from one of his cases illustrates admirably the peculiar positions assumed by the lower extremities in this remarkable deformity. It will be noticed that neither limb is in the ordinary adducted position of hip-disease, both being fully rotated outwards. Its mode of origin is somewhat obscure. The view to which Lucas inclines is probably the correct one, viz., that the position is assumed, probably unconsciously on the part of the patient, with the object of placing the limbs in the most favourable positions for progression. One leg is usually affected first—after a time the other follows. Progression is from the knees, not the hips. The two limbs usually become equally affected—but in a case that I saw with Tyson, of Folkestone, the left was crossed over the right, the latter being nearly straight. Should it be thought desirable to attempt to correct this deformity, an anæsthetic should be given, and if the ankylosis is not perfect, the adhesions must be broken down and the limbs straightened. If the ankylosis is osseous, the neck of the femur on either side must be cut across with saw or chisel, and the limbs brought into position.

CHAPTER LIII.

DISEASES OF SYNOVIAL MEMBRANES, AND OF MUSCLES.

DISEASES OF BURSÆ.

THE bursæ which naturally exist, either under the skin, beneath the muscles and ligaments, or around tendons, are subject to various diseases. These sacs are sometimes developed from continued friction in situations where they are not naturally met with; thus, for instance, bursæ have been found at the projecting point of a hump-back, on the prominent parts of club-feet, or at the extremity of a stump. These abnormal bursæ also may become diseased.

Situations in which Bursæ exist.—Bursæ are either deep-seated or subcutaneous. The deep bursæ are as a rule more perfectly developed, closely resembling true synovial sacs, and in many places communicating with the cavity of a neighbouring articulation. The subcutaneous bursæ, situated over prominent bony points, appear to be little more than enlarged areolar spaces, and are in most places acquired after birth as the result of friction. The following are among the most important situations of the bursæ. On the front of the neck, according to Verneuil, there are three bursæ, one in front of the pomum Adami, one in the thyro-hyoid space, extending to the under surface of the hyoid bone, beneath the sterno-hyoid muscles, and another above the hyoid bone between the genio-hyoid and genio-hyoglossus muscle of the opposite sides. Beneath the deltoid and the acromion process is a large bursa, often communicating with the shoulder-joint. In the neighbourhood of the elbow are a large subcutaneous bursa over the olecranon, and a small one between the biceps tendon and the bone immediately above the insertion of the muscle. In the neighbourhood of the hip are three bursæ about the great trochanter, a large one between it and the gluteus maximus, and two smaller sacs between the smaller glutei and the bone. Another bursa of considerable size lies over the tuberosity of the ischium. In front of the joint is a bursa beneath the psoas and iliacus muscles, frequently communicating with the cavity of the articulation. In the neighbourhood of the knee there are two bursæ in front, the bursa patellæ between the deep fascia and the bone, and that beneath the ligamentum patellæ, between it and the upper part of the tubercle of the tibia. Occasionally the upper part of the synovial pouch of the knee is shut off from the general cavity of the joint, and forms a separate bursa beneath the extensors. In the ham there is a large bursa between the inner condyle of the femur and the gastrocnemius which frequently communicates with the joint, a similar smaller bursa on the outer side, another between the biceps tendon and the external lateral ligament, and others beneath the semimembranosus, the popliteus, and the sartorius, gracilis and semitendinosus—between these muscles and the bone. At the heel there is a large bursa between the tendo Achillis and the os calcis. The above bursæ are all well-developed and constantly present, and are those most liable to disease; but in addition to these a number of less perfectly formed subcutaneous sacs are met with in all parts of the body. The most important of these are in the following situations:—behind the angle of the lower jaw, on the symphysis of the chin; on the acromion, the external and internal condyles of the humerus, the styloid processes of the ulna and radius; on the dorsal surface of the metacarpo-phalangeal articulations, and on the dorsal aspect of the phalangeal articulations; on the anterior superior spine of the ilium; on each condyle of the thigh-bone, the tuberosity of the tibia, the two malleoli, the dorsal aspect of the toes, and on the plantar aspect of the heads of the first and fifth metatarsal bones.

Morbid Alterations.—The continued irritation of bursæ by the pressure that is exercised upon them, may cause them to inflame, to enlarge, to become thickened, or to undergo various other changes in structure. This enlargement of the bursæ in particular situations is often connected with special employments, by which continuous and severe pressure is exercised upon certain parts of the body; thus frequent kneeling will occasion enlargement of the bursa patellæ, hence called "housemaid's knee;" miners are occasionally subject to an enlargement of the bursa lying over the olecranon, hence called "miner's elbow" (Fig. 610); and weavers to the same condition in that over the tuberosity of the ischium, giving rise to "weaver's bottom."

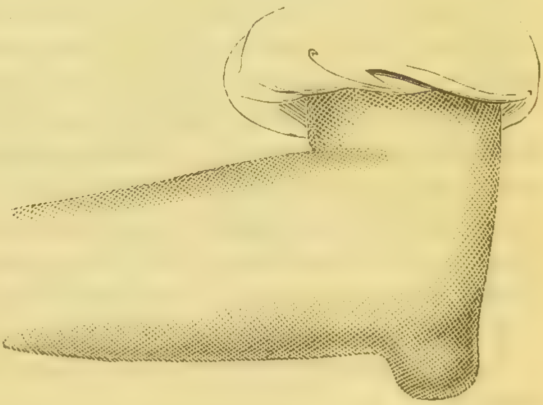


Fig. 610.—Enlarged Bursa over Olecranon—Miner's Elbow.

The five following pathological conditions may occur in the bursæ in any part of the body:—

1. The bursa may, in consequence of continued pressure or irritation, become simply enlarged and filled by the excessive secretion of a clear straw-coloured serous fluid.

2. Inflammation may take place in the bursa with or without previous enlargement. The inflammation so set up speedily runs on to suppuration; and when the tumour is opened, fluid, consisting of an admixture of the bursal secretion and pus, escapes. The bursa, when its contents have suppurated, may either give way externally, pointing like an ordinary abscess, and the integuments covering it sloughing; or the pus may escape subcutaneously beneath the deep fascia, and form a widely spreading abscess around the part.

3. The enlarged bursa may contain a dark fluid, usually of a brownish colour, with a large number of small flattened elongated bodies of about the size of grains of rice or of melon-seeds, floating in it. The wall of the bursa is thickened and, according to Nicaise, the presence of tubercle nodules has in some cases been demonstrated in the dense fibroid tissue of which it is composed. The melon-seed bodies are of a fibroid structure, and their mode of origin is not certain. They have been supposed to be formed in some cases by a fibrinous exudation into the cavity of the bursa, their peculiar form being the result of the movement of the part. In other cases they have been

supposed to arise from villous growths similar to those observed in the synovial membranes of joints. That they may be formed from extravasated blood also seems probable from the fact that S. G. Shattock has discovered crystals of hæmatoidin in some of the specimens in the museum of University College. The fluid is sometimes found to contain cholesterine.

4. The wall of the bursa may gradually become thickened by a growth of dense fibroid tissue, until the tumour becomes perfectly solid, or at most contains but a small cavity with a little serous fluid in its centre. The section of a bursa thus solidified presents a laminated or foliated appearance.

5. Occasionally in gout, bursæ may become the seat of a deposit of urate of soda. This is most commonly met with in the bursa over the olecranon.

The symptoms of the diseases of bursæ in general will be best studied by considering them as they occur in the bursa patellæ, which, from its exposed situation, and its liability to injury, is more prone to become diseased than any other similar structure in the body. I shall therefore first describe the symptoms and treatment of that bursa, and subsequently briefly allude to the similar morbid conditions in some of those situated in other parts.

DISEASES OF THE BURSA PATELLÆ.—The various affections to which the bursa is liable, may be divided into two classes: 1. Inflammatory affections; and 2. Enlargements, of a fluid or of a solid character.

1. **Inflammatory Affections.**—This bursa is frequently the seat of **Simple Inflammation.** Undue pressure in kneeling upon a hard, irregular, and cold surface, such as stone, is likely to excite inflammation: hence its frequency in housemaids, whose occupation obliges them to kneel a great deal on floors and stone steps; and hence, also, the common title of "housemaid's knee," given to this and to many other affections of this bursa. But this disease, although frequent among housemaids, is not limited to them; for it occurs in females following other occupations, and in men as well as in women.

In simple inflammation, however occasioned, the bursa becomes rather suddenly swollen, tense, red, and hot, with some fluctuation deeply under the integuments. The swelling, heat, fluctuation, and redness of a dusky colour all situated in front of the patella, indicate the nature of the affection.

The **Treatment** of this inflammation is simple enough. The application of glycerine and belladonna ointment and hot fomentations, and keeping the patient at rest, are the means to be employed. Under this treatment, the disease will frequently undergo resolution in the course of a few days. If very acute, two or three leeches may be of service. It may, however, go on to suppuration, and in rare cases, to disease of the patella itself, or sloughing of the bursa.

Suppuration of the Bursa occurs in perhaps the majority of cases of acute inflammation. This is a matter of great consequence; because the accumulation of pus, being of large size, and tending to diffuse itself around the knee-joint, is liable to be mistaken for abscess in that articulation. Sometimes it will point, and the pus discharge itself externally in the usual manner; but very generally it gives way subcutaneously, invariably to the outer side of the sac, and its contents speedily diffuse themselves widely around the joint beneath the fascia lata.

The history of the case affords the means of diagnosis. In suppuration of the bursa patellæ, the abscess commences by a superficial swelling and inflammation in front of the knee, which, after a time, extends laterally, enveloping the joint, the fluid gravitating on each side, but more especially on the outer one, nearly as far, perhaps, as the ham-strings. There will have been none ot the signs indicative of acute arthritis accompanying the formation of this large abscess; no startings of the limb, no laxity or pain in moving the articulation, no grating of the articular ends; and little if any constitutional disturbance. The movements of flexion and extension of the joint are free up to a certain point, where they are checked by the mechanical obstacle of the purulent accumulation. But the most important diagnostic sign is the relation of the abscess to the patella. In a suppurating bursa, the patella is invisible, being covered by the fluctuating swelling; in effusion, whether synovial or purulent, into the joint, the patella is above, floating upon the fluid.

The **Treatment** of this condition is simple enough. A free incision must be made to let out the pus, and this should be done if possible before the abscess has extended beyond the natural limits of the bursa. The incision is usually made in the middle line, but better drainage is obtained, and the scar over the knee-cap avoided if the incision be made at the outer side. To do this, a very small puncture may be made in front, and a probe introduced, the point of which may be made to project at the outer limit of the cavity. The probe may then be cut down upon, and a drainage-tube introduced, the anterior puncture being allowed to close. If the abscess be of considerable size, an incision must be made on each side, care of course being taken not to cut so deeply as to injure the capsule of the joint. If antiseptic precautions are taken, it is necessary only to make an opening of sufficient size to admit a drainage-tube, but under other circumstances, the incision must be much more free. The burrowing beneath the fascia lata that not unfrequently follows abscess of the bursa patellæ, is due first, to not opening early enough, secondly, to insufficient drainage, and thirdly, to decomposition of the discharges, and cannot be regarded as an unavoidable accident.

Disease of the Patella.—Sometimes, but very rarely, abscess of the bursa patellæ will give rise to disease of the patella itself. Caries of this bone secondary to suppuration of the bursa, is, so far as my experience goes, exceedingly rare. I have seen one case of the kind—that of a woman who was in the Hospital, under my care, several years ago. When admitted, she had several fistulous openings on the fore part of the knee-joint, through which the probe led down to a rough and carious patella. On inquiry it was ascertained that she had had inflammation of the bursa patellæ—"housemaid's knee"—which had run on to suppuration, but that the abscess had never been freely laid open. The present condition had resulted from that suppuration. The joint itself was unaffected; there was no pain in it, and its movements were perfectly free. I laid open the sinuses, and, finding the anterior surface of the patella soft and carious, removed with the gouge the diseased bone to which they led. About two or three weeks after this, the joint became suddenly swollen, evidently filled with pus, and the seat of acute pain. In consequence of the severity of the symptoms, it became necessary to remove the limb above the knee. After amputation, it was found that the disease had extended through the patellar cartilage, perforating it by a small aperture, and had so given rise to suppuration within the joint.

Sloughing of the Bursa Patellæ occasionally occurs as the result of its inflammation and suppuration. A woman was admitted into the Hospital, in whom this bursa had inflamed and suppurated ; and not only the bursa but also the integuments covering it had sloughed away, leaving in front of the knee a circular ulcer as large as the palm of the hand, having a flabby surface, and undermined, purple edges. The patella was not exposed. Under ordinary treatment, the ulcer slowly healed.

2. **Enlargements.**—In the second variety of disease of the bursa patellæ there is enlargement of the bursa without evident signs of inflammation, owing to the accumulation within it of bursal fluid, or of this fluid mixed with solid bodies, or of solid fibroid deposits.

Simple Enlargement, or **Dropsy of the Bursa.**—The bursa may present a simple enlargement, dependent on the accumulation of fluid in its interior. Continued pressure exercised upon the bursa, as in kneeling, is the common cause of this affection ; hence it frequently occurs amongst housemaids, and constitutes the true "housemaid's knee." But it is also common amongst other people, whose vocation necessitates long-continued kneeling. One case of the affection in University College Hospital was in a carpet-layer, a man aged thirty, who, in consequence of habitually kneeling upon the left knee in laying down carpets, had a tumour there as large as an orange, indolent, soft and fluctuating, evidently an enlarged bursa.

The **Treatment** of these tumours is very simple. If the effusion has taken place somewhat rapidly, and distinctly in connection with some injury, the application of tincture of iodine or a blister, will succeed in inducing absorption of the contained fluid. When the disease is more chronic, these measures usually fail. The fluid may then be withdrawn by means of the aspirator and pressure applied with an india-rubber bandage. Tapping the sac with a trocar, and passing a seton through the cannula, either by means of a long straight needle, or by using an eyed probe, and cutting down upon the end of it with a scalpel was formerly a common mode of treatment. The seton-threads were left in until they excited free suppuration. The danger of this treatment was that more pus might form than could readily drain away by the apertures through which the seton passed, and consequently a septic abscess of the bursa not uncommonly resulted, requiring a free incision for its relief. In order to avoid this risk antiseptic drainage should be substituted for the seton. A small puncture is made, and an india-rubber drainage-tube inserted with all antiseptic precautions. In many cases a week or ten days' drainage will suffice to correct the tendency to over-secretion without any inflammation or suppuration being set up. The result is, however, made more certain by exciting a slight degree of simple inflammation by injecting the cavity at the time the tube is inserted with carbolic acid lotion (1 in 20), or solution of chloride of zinc (20 gr. to ℥j), or tincture of iodine.

Chronic Enlargement with Melon-seed bodies.—This affection is closely allied to the last, and appears to be an advanced degree of it. It consists in a chronic enlargement of the bursa, the coats of which are more or less thickened. The contents of the enlarged bursa consist of a dark fluid, in which float a number of smooth oval bodies, of the size and shape of melon-seeds. I have seen this condition in both the male and the female. It may be distinguished from simple enlargement of the bursa, by the peculiar crackling sensation which is communicated to the hand when the tumour is manipulated. This arises from the melon-seed bodies floating about and rubbing against each other.

The *Treatment* of this affection consists in making an incision, with antiseptic precautions, free enough to allow the melon-seed bodies to pass out. The cavity may then be syringed out two or three times with carbolic acid lotion, to ensure the removal of all the solid bodies ; a drainage-tube is then inserted and retained for a week or ten days, the wound being treated by some form of antiseptic dressing. If the wall be much thickened the whole bursa should be dissected out.

Solid Tumours may be formed in connection with the bursa patellæ. By many these are supposed to be the result of a deposition of a fibroid material, which gradually takes the place of the fluid of an ordinary "housemaid's knee," and which, instead of taking the form of melon-seed bodies, is deposited in concentric masses. This has not been the case, however, in many instances that I have seen. In these cases I believe there is a true fibroid growth in the wall of the bursa from the very first; the tumour is never fluid, but hard and solid from the commencement, and continues slowly to augment in size, until it occasions sufficient inconvenience to require removal. In some cases there has been a previous syphilitic taint. The patient complains of pain in the tumour like that which is experienced in nodes, and it is by no means impossible that there may be a syphilitic origin for these tumours. However that may be, in the cases that have fallen under my observation, the tumours have never been fluid, nor have they originated in pressure, but appear to have been primary growths of fibroid matter.

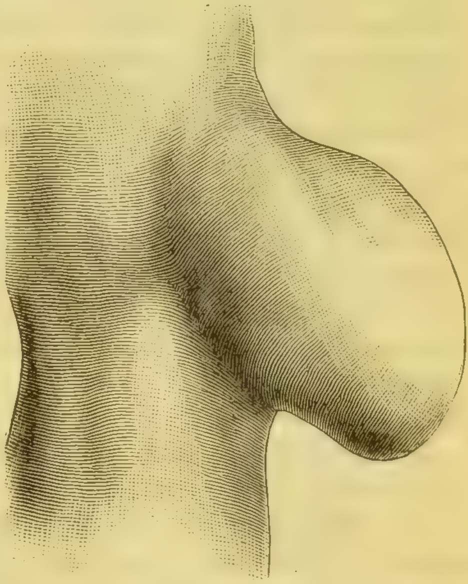


Fig. 611.—Very large solid tumour of the bursa patellæ. Both knees were similarly affected.

Treatment.—There is nothing to be done with such tumours but to dissect them out. With the most ordinary care the joint runs no risk ; but much trouble may arise from opening up the deep fascia surrounding the knee. Such an accident is liable to be followed by infiltration and deep abscess in the ham, unless careful attention be paid to drainage and to the prevention of decomposition in the discharges. In order to provide more efficient drainage, it will often be found convenient to remove the bursa by a curved incision at the outer border of the tumour instead of in the middle line.

Diseases of other Bursæ.—The diseases of the Bursa Patellæ being taken as the type, the affections of the other more important bursæ require to be but briefly alluded to.

Enlargement of the Pre-hyoidean bursa or of that between the genio-hyoid muscles is not very uncommon, forming a large, thin-walled fluctuating tumour in the front of the neck and beneath the chin. When the bursa between the genio-hyoid muscles is the seat of disease, the cyst may push up into the floor of the mouth between the genio-hyoglossi. When the pre-hyoidean bursa is affected the cyst tends to extend downwards over the larynx, forming one of the varieties of the so-called "hydrocele of the neck."

Treatment.—These cysts can usually be cured by tapping, with injection of chloride of zinc or tincture of iodine, followed by antiseptic drainage. The walls are too thin and their attachments too deep to make it advisable to attempt their removal by dissection.

The **Bursa beneath the Deltoid** is not uncommonly enlarged. The affection assumes most frequently the form of simple chronic enlargement with or without the presence of melon-seed bodies. It forms a rounded swelling, causing prominence of the deltoid with distinct fluctuation. In some cases enlargement of this bursa is connected with chronic tubercular disease of the shoulder-joint, which should always be carefully looked for. The *Treatment,* if the joint is not diseased, consists in aspiration and blistering. Should this fail, or should the soft crackling on movement show the presence of melon-seed bodies, an incision may be carefully made at the most convenient spot, and the sac emptied and drained for a week or ten days. This operation must not be undertaken without due consideration, and must be performed with the strictest antiseptic precautions, as the bursa frequently communicates with the articular cavity, and any septic process occurring in it would almost certainly lead to destruction of the shoulder-joint.

The **Bursa over the Olecranon.**—Inflammation of this bursa ending in suppuration is a common result of falls on the elbow, with or without a wound. It causes severe pain and redness, with œdema extending a long way above and below the joint. The pus may burrow some distance down the forearm unless sufficiently free incision be made early. The inflammation very rarely extends to the elbow-joint, but superficial necrosis of the olecranon sometimes occurs. Chronic enlargement with some thickening of the walls forms the affection known as "miner's elbow." Solid tumours of the bursa are rare. It is not uncommon to find the bursa the seat of gouty deposits. The *Treatment* of these affections is conducted on exactly the same principles as in the corresponding conditions at the knee.

The **Bursæ about the Trochanter Major** are occasionally the seat of chronic inflammatory enlargement or dropsy, and of acute inflammation terminating in suppuration. The latter condition is of great importance from its simulating hip-disease, or sometimes causing it by implication of the joint. The diagnosis can be made only by observing that the characteristic deformity of the hip is absent, and on opening the abscess the finger will not be able to detect either diseased bone or any connection with the joint. The treatment is conducted on ordinary principles.

The **Bursa over the Tuberosity of the Ischium** is sometimes enlarged, forming the condition termed " Weaver's bottom." The enlargement is often solid, and may cause great discomfort in sitting. Under these circumstances it may be safely removed by the knife. It will be found to be in part deeply seated under the lower part of the gluteus maximus. It is not clearly circumscribed, its outer wall being continuous with the surrounding fat. There may be rather free bleeding, but this is easily arrested.

The **Bursa beneath the Psoas** is rarely enlarged, but cases have been recorded in which fluctuating tumours, containing serous fluid, have been met with in the groin, and have been supposed to have arisen in this way. These tumours are deeply seated, and closely resemble psoas abscesses; they become tense when the thigh is extended and lax during flexion. Their true nature can be ascertained only by the use of the aspirator. They must be treated on the principles already laid down, but the frequent communication of this bursa with the hip-joint must be borne in mind.

The **Bursæ in the Ham,** especially that beneath the inner head of the gastrocnemius, not unfrequently become enlarged. Their walls become slightly thickened, but melon-seed bodies or solid enlargement are rare. The distended bursa forms a fluctuating swelling, which becomes tense during extension of the joint and lax during flexion. There may be some slight pulsation communicated from the popliteal artery, and the swelling may thus resemble an aneurism, but the pulsation is not expansile, and the tumour does not diminish in size on compressing the femoral artery. Sometimes by firm pressure the cyst may be made partially to empty itself into the knee, the signs of fluid in the joint then becoming apparent. These enlarged bursæ in the ham usually cause but little pain. The skin covering the swelling is normal in appearance. The *Treatment* must be conducted with caution, owing to the close proximity, if not actual communication, of the bursal tumour with the joint. Painting with tincture of iodine and blistering with elastic pressure may be first tried; if that fails aspiration followed by pressure may be tried; if that is not successful injection with iodine may cure the disease. When everything else has failed, antiseptic drainage will usually effect a cure. In one case, after every other means had failed, Johnson Smith successfully dissected the cyst out, leaving the pedicle which passed under the gastrocnemius. The operation was performed under the carbolic spray, and the wound treated antiseptically.

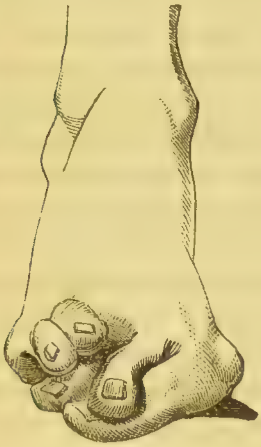


Fig. 612.—Distorted Foot, from Pressure and Bunion.

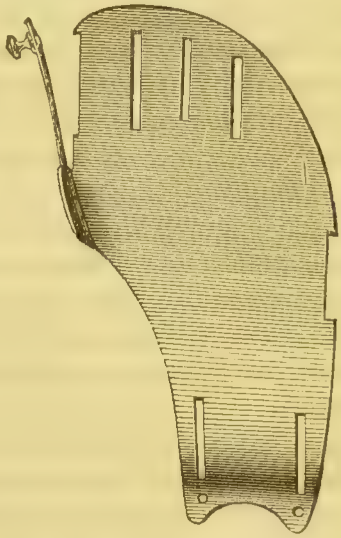


Fig. 613.—Apparatus for Deformity of Foot, as in Fig. 612.

The **Bursa beneath the Tendo Achillis** at the heel is sometimes diseased. It forms a fluctuating swelling on each side of the tendon, and may simulate disease of the ankle-joint. The treatment presents nothing peculiar.

Bunion.—When the bursa which lies towards the plantar surface of the head of the metatarsal bone of the great toe becomes enlarged, or when a new sac is formed upon the inner and posterior aspect of this bone, the disease termed a *bunion* occurs. In this affection, the enlargement of the bursa is usually secondary to an alteration in the shape and position of the great toe, which in consequence of the pressure of narrow-pointed boots, or from alteration in the shape of the bone from arthritis deformans, has been thrown outwards in an oblique direction, so as to lie over or under some of the contiguous digits (Fig. 612); in this way a sharp angle is formed at the junction between the first phalanx and the metatarsal bone of the great toe. This angle, being constantly pressed upon by the boot, becomes irritated; and, for its protection, the bursa that is there naturally situated becomes enlarged, or an adventitious one forms. From time to time the bursa and the projecting angle become irritated and inflamed; and the morbid process thus set up may run on to suppuration, a thin, unhealthy pus being formed, which is discharged through an opening that becomes fistulous, and may degenerate into a most troublesome indolent sore.

Treatment.—In the treatment of this affection, the first thing to be done is to relieve the pressure on the part by wearing properly shaped boots, made with the inner side of the sole straight from the toe to the heel. If accidental inflammation be excited in the part, it must be allayed by the use of warm foot-baths, and fomentations; the cutaneous irritation that is left may best be removed by painting the surface with a strong solution of nitrate of silver. The faulty direction of the toe may be remedied by using the ingenious contrivance (Fig. 613), the action of which consists in drawing the everted end of the toe inwards by the constant action of a slender steel spring. Should these means fail, the position of the toe may be remedied by the division of the external lateral ligament of the metatarso-phalangeal articulation, or of the tendon of the adductor pollicis, or of the inner head of the flexor brevis pollicis; the toe, when restored to its position, being for a time kept fixed upon an under-splint.

As these methods of treatment are, however, seldom successful, it has been suggested by C. Hoar to perform antiseptic osteotomy of the metatarsal bone of the great toe through the neck of the bone. This operation has been most successfully performed by A. E. Barker in one case, and deserves a further trial. Barker removed a small wedge-shaped piece from the inner side of the metatarsal bone, and fracturing the remainder, brought the toe at once into good position.

Occasionally in elderly people the bunion will inflame and suppurate, and the mischief, extending to the metatarso-phalangeal articulation, will cause disorganization of the joint. This is a state of things not devoid of anxiety, as it not unfrequently happens that, if the constitutional powers be enfeebled by age, a sloughing inflammation may be set up in the foot, which eventually may terminate fatally. Should the joint be irretrievably disorganized, and the patient's strength admit it, the toe should be removed by amputation—after which the carious head of the metatarsal bone will usually heal without difficulty.

DISEASES OF SHEATHS OF TENDONS.

The synovial sheath of a tendon is liable to two forms of disease; viz., the development of a small sac in immediate connection with it, forming a cystic tumour; and acute and chronic inflammation or tenosynovitis. The tendons of the hand are most liable to both these affections.

Ganglion.—The term "ganglion" is applied to both these conditions, and thus leads to some confusion. The *simple* ganglion is a small cyst of new formation in close connection with a synovial sheath; the *compound* is a dilatation of the sheath itself, and is a consequence of chronic tenosynovitis.

Simple Ganglion consists of a cyst varying in size from a cherry-stone to a large marble, and containing sometimes a clear transparent fluid of a yellowish colour, but more commonly a pinkish or yellowish gelatinous substance. It occurs as a smooth, globular, elastic, and tense tumour, usually situated on the back of the wrist, where it forms a distinct round projection; it may occur also on the dorsum of the foot. In both situations it is distinctly connected with the sheaths of the extensor tendons. As the ganglion increases in size, it often gives rise to painful sensations in the parts below it, by pressing upon the neighbouring nerves: thus, a ganglion at the back of the wrist often produces pain and weakness in the hand, by compressing some of the branches of the radial or ulnar nerve which are stretched over it.

Ganglion is by far the most common of all the tumours that occur on the hand. In all cases of oval or rounded, smooth, elastic tumour on the hand or fingers, whether painless or neuralgic, the first point to determine is whether it be ganglion or not; but ganglion should always be suspected.

A small, hard, and painful ganglion, varying in size from a pin's head to a cherry-stone, is met with in connection with the flexor tendons of the fingers, usually on the proximal phalanx. If it interferes seriously with the use of the fingers, it may be dissected out.

The mode of origin of a simple ganglion is very doubtful. Paget looks upon it as a cystic transformation of the cells enclosed in the fringe-like processes of the synovial membrane lining the sheath of the tendon. Billroth believes it commences as a pouch-like protrusion from the sheath, the neck of which becomes gradually narrowed till at last a separate cyst is formed lying on the sheath, but not communicating with it. There is no real evidence in support of either of these views.

Treatment.—When the ganglion is small, as on the back of the wrist, it may commonly be got rid of by being ruptured by forcible pressure with the thumb, or by a sharp blow, or by being tightly compressed, by means of a coin wrapped up in lint, and firmly strapped upon the swelling, or by a spring-compressor. If it do not disappear in this way, the best plan is to puncture it subcutaneously by means of a valvular opening, to squeeze out its contents, scarify the interior of the cyst, and employ pressure. If the ganglion give rise to much pain and weakness, and cannot be made to disappear by the use of the means just indicated, it may usually be very conveniently and safely obliterated by passing two threads of carbolised silk or horse-hair through it, dressing it antiseptically, and leaving it in for four or five days, until sufficient inflammation has been induced for the obliteration of the cyst. Should these means fail, it may be dissected out; a procedure which is attended with some risk of inflammation extending up the sheath of the tendon, unless perfect asepsis is maintained. I have on several occasions performed this operation, without any troublesome consequences ensuing.

Inflammation of the Sheaths of Tendons—Tenosynovitis.—This is occasionally met with as the result of strains and twists of the hand, about the wrist, of the extensor tendons, or the long head of the biceps. It is very common in the extensor muscles of the thumb from feathering the oar in rowing. In this affection there is swelling of a puffy character, with tenderness when the part is pressed on or moved: and usually a peculiar fine crackling sensation is communicated to the Surgeon's hand when he examines the affected part. The crackling is especially marked in cases in which the inflammation and effusion have become chronic, when the disease appears to partake of the nature of a diffused ganglion.

Treatment.—The treatment, when the disease is acute, consists in the application of gentle pressure by means of a bandage, with rest of the part; when it has assumed a chronic character, the application of blisters and the mercury and ammoniacum plaster will be found most useful.

Compound Ganglion is a chronic effusion into the sheath of a tendon without any manifest signs of inflammation, though it is usually regarded as a very chronic inflammatory process analogous to chronic synovitis of a joint. Nicaise has in two cases demonstrated the presence of tubercle-nodules in the diseased serous membrane. Compound ganglion is met with chiefly in the palm of the hand, but it has been observed on the dorsum, sole, or inner side of the foot. It may often attain a very considerable size, and then usually becomes irregular in shape, owing to several tendons being implicated by it. Often, in this form of ganglion, the sheath is thickened as well as dilated; and the contained fluid is clear and yellowish, though usually thinner than in the simple ganglion. The sheath itself is vascular, and lined by a red, fringed, and velvety membrane; the fluid may then be dark and bloody, and contain masses of buff-coloured fibrin or a large number of granular bodies, like those met with in certain forms of enlarged bursæ. The appearance of a so-called compound ganglion at the wrist may in some cases be the first indication of disease of the bones of the carpus, as the synovial sheath comes in close contact with the bones. In a case lately in University College Hospital, the compound ganglion, which contained melon-seed bodies, was apparently cured by antiseptic drainage. Some months after caries of the carpus manifested itself, necessitating excision of the wrist-joint.

Treatment.—A ganglion situated in the palm of the hand, and extending under the annular ligament some little distance up the flexor tendons of the forearm, is a very troublesome disease. Syme recommended that the sac should be laid open, and the annular ligament divided. This seems to me an unnecessarily severe procedure; and I have in several instances cured the affection by milder means; in one, by injecting a small quantity of tincture of iodine into the cyst through a puncture in the palm, and in two or three other cases by the use of the seton. The seton is most easily introduced by squeezing the fluid from the palm into the sheaths of the flexor tendons above the wrist, making a puncture into these, and then pushing an eyed probe armed with two or three threads along the tendons under the annular ligament into the centre of the palm, where it is to be drawn out through a small incision made down upon it. The seton threads must be of thoroughly carbolised silk, and the operation and dressing must be conducted on antiseptic principles to avoid suppuration. An india-rubber drainage-tube may be substituted for the silk thread. Compound ganglia in other situations must be treated on similar principles.

DISEASES OF MUSCLES.

The voluntary muscles are not often the seat of primary disease of any kind, **Fatty Degeneration** of muscle, as met with in surgical practice, is usually the result of want of use. In such cases, the muscular fibres are merely atrophied, and the fat, which resembles normal adipose tissue, is accumulated between them. Such a condition is recovered from if the cause of the want of use be removed. True fatty degeneration, in which the protoplasm of the muscular fibres undergoes conversion into fat-granules, is not common in the voluntary muscles, except as a result of complete separation from a healthy nerve centre. **Ossification of Muscles** or **Myositis Ossificans,** that is to say, gradual atrophy of the muscular fibres with the development of bone from the connective tissue between them, has been met with in very rare cases, chiefly in the muscles of the back. The disease occurs in young subjects. **Inflammatory Affections** are usually secondary, the muscle being implicated by extension from surrounding parts. Diffuse inflammation of the voluntary muscles with disseminated abscesses has been observed in pyæmia. Abscesses, as we have already seen in psoas abscess, may enter the sheaths of muscles and cause considerable destruction of tissue. "**Rheumatic inflammation**" of muscles is met with as lumbago, intercostal rheumatism, &c., but of the exact nature of the process we know but little.

Syphilitic Disease of Muscles has been already described (Vol. I., p. 1153). It occurs as diffuse sclerosis of the muscle or gummata. Gummata have been met with in the triceps, vastus externus, sterno-mastoid, and many other muscles, but especially in those of the tongue. They grow slowly, infiltrate surrounding parts and soften if not relieved by treatment. They are not unfrequently multiple. They are accompanied by aching pain, and stiffness of the affected muscle. They derive their importance chiefly from their resemblance to some of the tumours to be immediately described, which has occasionally led to their being cut out. The diagnosis is effected by the history of syphilis, the slow growth and hardness of the tumour, its subsequent softening, and the pain at night. They disappear or diminish rapidly under iodide of potassium.

Tumours of Muscle.—Primary tumours of muscle are not common. The growths met with are the various forms of sarcoma, sometimes containing much fibrous tissue (fibro-sarcoma), sometimes soft (round-celled or spindle-celled sarcoma), chondromata, myxomata, fibromata, nævoid growths, and hydatid cysts. Primary carcinoma of muscle never occurs. Teevan collected with much industry the particulars of 62 cases of tumours of muscles of all kinds; about one-third of these were soft sarcomata, 16 were described as fibrous, 8 cystic, 5 hydatid, and 5 nævoid. Malignant sarcomata are most common according to my experience in the lower limb. When the upper limbs are affected, the muscles that have, according to Teevan, been most frequently attacked are the pectoralis major, deltoid, and biceps. The muscles of the trunk and neck are seldom diseased, with the exception of the rectus abdominis, which appears to be very liable to tumours.

Of twelve consecutive cases that I have had under my care in which tumours of different kinds developed primarily in muscular tissue, the following are the particulars. The first case was that of a woman about 48 years of age, in whom a fibro-cystic tumour, as large as a cocoa-nut, developed in connection with the tensor vaginæ femoris, forming a large mass, which I dissected out readily from over the hip. The second case was that of a lad about 18, in whom a cystic tumour, as large as a fœtal head, thick walled, and containing clear fluid, developed in the substance of the adductor brevis of the thigh, from which it was dissected out with no little difficulty, and with a fatal result. The third case was that of a man from whom the accompanying drawings are taken (Figs. 614, 615, 616), in whom a fibro-sarcoma developed within the sheath of and in the substance of the sartorius muscle of the left thigh, in consequence of a strain. After growing slowly for about six years, it had attained the size of a child's head, when I removed it, together with seven or eight inches of the muscle from the inside of the sheath of which it had originated, and with which it was closely incorporated. The sheath of the femoral vessels, which was exposed for a considerable extent, was unaffected by the disease. Recurrence took place in less than twelve months in the cicatrix, and when the secondary tumour had attained the size of an ostrich's egg, it was removed, the patient making a good recovery; but the disease again returned, and eventually proved fatal. The fourth case was that of a man aged about 40, in the sole of whose foot a cystic tumour, about as large as a goose's egg, was developed, springing from the flexor brevis digitorum. This was carefully dissected out; but in a few months the patient returned, with a solid, elastic, rapidly growing tumour, evidently a malignant sarcoma, developed in the cicatrix (Fig. 617). The foot was amputated, and on section the mass proved to be a soft sarcoma, and to have developed from the muscular structure just named (Fig. 618).

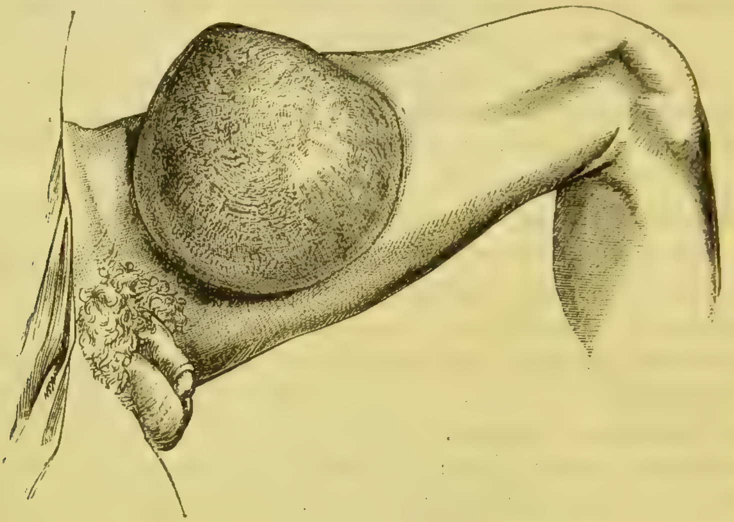


Fig. 614.—Fibro Sarcoma of the Sartorius Muscle.

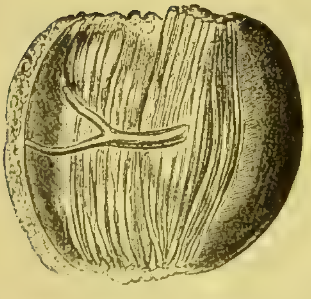


Fig. 615.—Back View of Tumour, showing Sartorius Muscle.

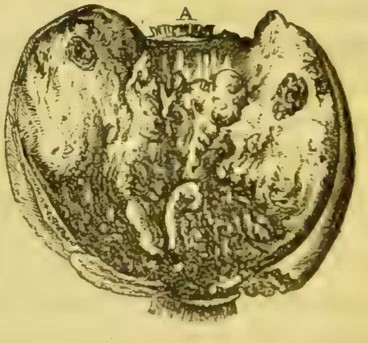


Fig. 616.—Front View of Tumour, laid open and showing Sartorius, A.

In three cases the tumours were hydatid. In one patient, a young woman, the disease was seated in the deltoid ; in another, a medical man, about 50 years of age, the tumour was seated at the outer edge of the latissimus dorsi ; and the third was a gentleman about 60 years old, in whose biceps the disease commenced. In each of these cases, excision of the tumour was successfully practised.

In the eighth case the tumour was a chondroma in the tibialis anticus. I have seen two other cases of chondroma in muscles ; one situated in the vastus externus of the thigh ; the other in connection with the pectoral muscle. The ninth case was a sarcoma of the rectus femoris in a man aged 21, which I excised ; the tenth, a malignant growth in the anterior abdominal wall in an elderly gentleman ; the eleventh, a soft sarcoma of the muscles of the calf in a middle-aged lady, for which amputation was practised ; and the twelfth, a sarcoma of the forearm in a lad.

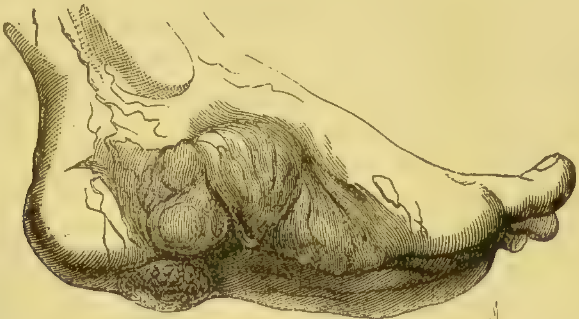


Fig. 617.—Malignant Tumour in Sole.

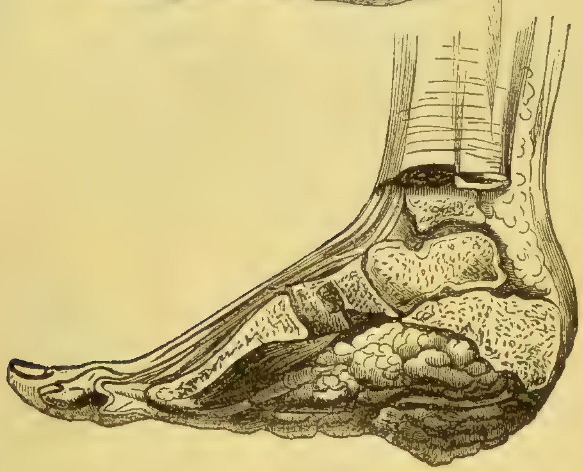


Fig. 618.—Section of Foot, showing situation of Tumour.

Tumours developing primarily in the intermuscular areolar planes are of common occurrence ; but these are very different from, and must not be confounded with, true tumours of muscle.

The *Treatment* of these various muscular tumours must be considered on ordinary surgical principles. When of an innocent character, as cystic or hydatid, fibrous, erectile, or chondromatous, they may be dissected out from the muscular tissue amongst which they lie, and no fear of recurrence need be entertained.

When they are malignant, amputation of the limb, if the tumour be favourably situated for such an operation, is generally the only resource : partial operations are usually worse than useless, as they are followed by a speedy recurrence. Teevan has made the ingenious suggestion of applying to malignant tumours of muscle the same rule of practice that guides us in operations on bones similarly affected ; viz., to remove the whole of the organ that is the seat of disease, excising the entire muscle from its origin to its insertion, and thus eliminating from the system the whole of the morbid mass, which will be confined within its sheath—a structure that for a long time resists the outward pressure of a morbid growth. The suggestion is founded on correct pathological principles ; the only objection to it is its difficulty of application in actual practice—there being few muscles so situated that they could with safety be completely extirpated.

CHAPTER LIV.

DEFORMITIES.

LATERAL CURVATURE OF THE SPINE.

THIS affection, on account of the frequency of its occurrence, the deformity it occasions, the tediousness and uncertainty of its cure, has received a good deal of attention from various Surgeons; and much has been written on it by those who have specially devoted themselves to its treatment; yet the whole of its pathology and management lie in a very narrow compass.

Lateral curvature of the spine most commonly commences at an early period of life, usually between the ages of twelve and eighteen—seldom before the one, and not very commonly after the other. Girls are most frequently the subjects of this deformity, which but rarely occurs in boys. It appears to consist simply in a relaxation of the muscles and ligaments of the spine; in consequence of which the vertebral column, being no longer able to support the weight of the head, neck, and shoulders, becomes curved to one side, a corresponding deviation taking place in the opposite direction at a lower portion of the spine, in order to preserve the equilibrium between the two sides of the body (Figs. 619, 620). The first curve usually takes place in the upper or middle dorsal region, the convexity tending towards the right side; the second, or compensating curve, occurs in the lumbar region, the convexity looking towards the left. In some instances there is a quadruple curve (Fig. 621). At the same time that these lateral curves take place, there is

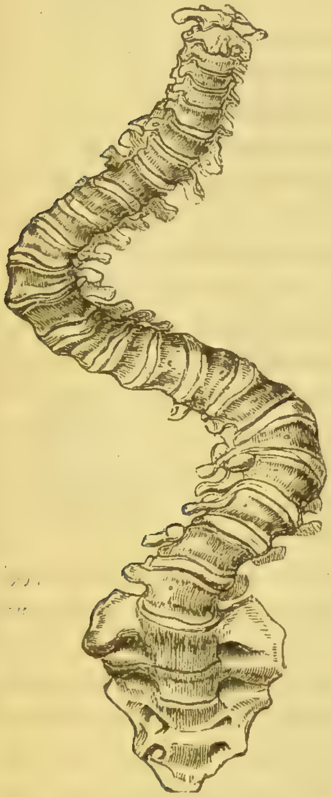


Fig. 619.—Lateral Curvature and Rotation of Spine.

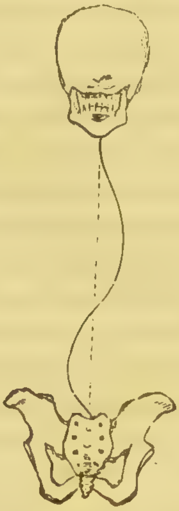


Fig. 620.—Outline of Double Lateral Curvature.

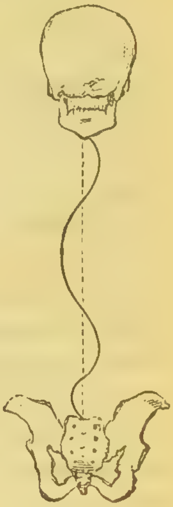


Fig. 621.—Quadruple Curve.

a tendency to rotation of the bones of the spine upon one another, in such a way that the bodies of the vertebræ forming the dorsal curve are twisted slightly to the right, while those which enter into the formation of the lumbar curve are turned slightly to the left (Fig. 619). This twist is sometimes slight; but in other instances it is very marked, so that there is a double displacement—lateral and rotatory.

On examining the bones and intervertebral fibro-cartilages after death, even in cases of very considerable distortion, no disease will appear in them; except that the bodies of some may have been slightly compressed where they form the principal concavity of the arch. This is altogether a secondary change, the primary cause of the deformity being a weakness of the muscles and ligaments supporting the spine. These, however, show no naked-eye changes.

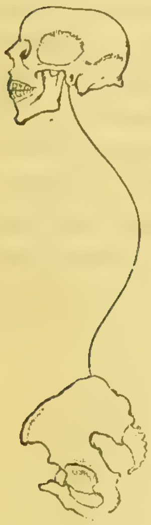


Fig. 622.—Kyphosis.

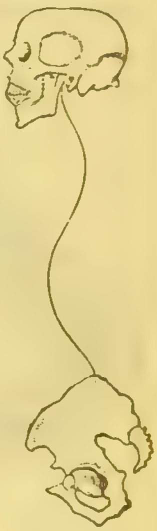


Fig. 623.—Lordosis.

Mechanism.—From a consideration of the pathology of this affection, its mechanism becomes sufficiently apparent. The spinal column, being composed of a number of separate bones, possesses no firmness in itself, or power of self-support, but is maintained in the erect position by the close manner in which its separate elements are knit together by ligamentous and muscular structures, and by the way in which, when thus bound together as a whole, it is supported on each side by the strong mass of the erector spinæ and its prolongations. The proper tension of these ligamentous supports and muscular masses is especially necessary for it to maintain the weight of the head and shoulders, which is thrown on the cervical and the upper portion of the dorsal spine. If, from any cause, the ligaments become relaxed, and the muscles lose their tone, or if the weight of the upper part of the body increase disproportionately to the augmentation in the strength of the ligaments and muscles that support the spine, the vertebral column will necessarily give way under the pressure to which it is subjected in a direct line from above downwards, and will consequently become curved. Most commonly, indeed almost invariably, this takes place in a lateral direction, the spine yielding more readily in this than in any other. In some rare cases, however, the lower portion of the cervical or the upper dorsal region will project backwards in an arched manner, constituting the disease termed **Kyphosis** (Fig. 622); and in other cases, of still less frequent occurrence, there may be incurvation of the spine in the dorso-lumbar region, giving rise to **Lordosis** (Fig. 623).

The directions in which these various curves take place are exaggerations of the natural inclination of the spinal column. In *lateral curvature*, the chief convexity takes place towards the right side, causing a projection of that shoulder which in most right-handed people is somewhat more prominent than the other. In *kyphosis*, the excurvation takes place in the lower cervical and upper dorsal regions, which are naturally prominent; and, in *lordosis*, the incurvation is most marked in the lumbar region, in which there is naturally a curve forwards.

Causes.—These various kinds of deformity, as has already been stated, usually commence in girls about the age of puberty ; at a time of life when the tonicity of the muscular system not unfrequently becomes lessened by the occurrence of anæmia and those states of impaired health that so frequently attend the establishment of the uterine function ; and before the osseous and ligamentous structures of the body are fully developed. At this period of life, also, it frequently happens that the spine becomes rather suddenly elongated by a rapid increase in growth ; or that it becomes overweighted by the body developing, and the shoulders and bust becoming unduly stout and expanded. Indeed, so frequent is the occurrence of a certain degree of lateral curvature of the spine from these various causes, about the age of puberty in girls, that few escape a tendency to deviation ; of so slight a kind, however, as not to admit of recognition as a disease. But if this tendency be increased by injurious habits, amongst which are all one-sided postures in which the body is twisted, as in playing certain games, some musical instruments, or in leaning over a table in drawing and writing, the slight deviation may rapidly increase until it assume the true characters of lateral curvature. Girls who grow too rapidly are especially predisposed to lateral curvature. Their strength does not keep pace with their growth. The feet, ankles, or knees often give way, and the spine inclines to one side. But lateral curvature is common also in girls of a totally different make. Young women of a short and thick build, in whom the bust and shoulders become largely and early developed, are very liable to lateral curvature. In them too great a weight is thrown on the spine before its osseous and ligamentous structures are sufficiently developed and solidified to enable it to support this burden. There is no evidence to show that this is either a strumous or a rickety affection ; indeed, so far as my observation goes, I should certainly say that strumous girls are less liable to the disease than those of a nervous temperament ; and it occurs at an age at which rickets is unknown. Amongst the more common predisposing causes must undoubtedly be reckoned the sedentary occupations and enervating habits commonly encouraged in girls in the wealthier ranks of life, which, by preventing due muscular development, at the same time that they induce a general loss of tone in the system, may directly occasion the disease. In growing lads, lateral curvature may be produced by a habitually maintained faulty position, as in sitting too long at the desk, or in following certain occupations. An inequality in the focal length of the vision of the two eyes is a very common cause of spinal rotation and lateral curvature, the patient habitually twisting the body forward on the side of the defective eye, so as to endeavour to accommodate the vision of it to that of the stronger one. That the real cause of lateral curvature of the spine is to be found in faulty habits of life, and not in sex, is evidenced by the rarity of the affection amongst girls of the labouring class, as compared with its frequency amongst those of the wealthier orders of society.

The causes of the antero-posterior curves are usually to be found in some faulty habits of the patient ; either giving rise to an habitual stoop, and thus laying the foundation for kyphosis, or throwing too great a weight on the loins, and thus giving rise to lordosis. Myopia and other impairments of vision causing the person so affected to stoop, in order to bring the page nearer the eye in reading, is a common cause of round shoulders, and in more extreme degrees of kyphosis.

Signs of Lateral Curvature.—The signs of this affection when it is well marked, are obvious. The serpentine character of the curve, its double nature, the convexity on one side usually looking to the right shoulder, and on the other to the left loin, will render its nature evident. Most commonly it commences in a gradual manner, the first condition that attracts attention being the prominence of the right scapula, which is supposed to be "growing out;" or the sterno-clavicular articulation on the same side, or some of the cartilages of the ribs, have been observed to project. Whenever the Surgeon is consulted for such symptoms, he should at once examine the spine, which he will generally find to have an inclination to the right side. In the early stages of the disease, when the deviation is not very distinctly marked, the readiest mode of determining it is to let the patient stand upright, taking care that the feet are well placed together, and that the attitude is not forced but natural; the Surgeon should then run his finger down the back from one spinous process to another, touching each as he passes it with a pen dipped in ink; in this way, when he has reached the lower part, he will have mapped out the course of the vertebral column, and thus may see at a glance the nature and extent of its displacement. At the same time, he will probably observe that the two hips do not exactly correspond, the left being somewhat thrown out. Very commonly there is a good deal of neuralgic tenderness about the spine, constituting the ordinary irritable or hysterical spine, and at this early stage there may be anæmia and symptoms of impaired nutrition.

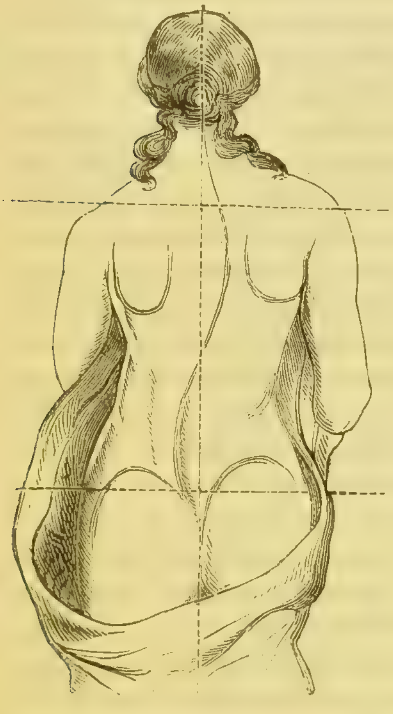


Fig. 624.—Lateral Curvature of Spine.

As the affection advances, the curvature becomes more marked, and at the same time, owing to torsion of the column, assumes a slightly angular character where most convex. The ribs on the right side are thrown out and bulging, and carry up the scapula with them, whilst those on the left are sunk and depressed (Fig. 624). In fact, the whole of the right side of the chest and body partakes in the projection of the spine on that side, and thus adds much to the general deformity; whilst the left side of the chest is correspondingly hollowed and sunk in. When the disease has advanced to this stage, general debility, emaciation, and pallor come on; the mal-nutrition of the body, which was the primary cause of the disease, being increased by the compression to which the thoracic and abdominal organs are subjected.

During the early period of the case, the spine preserves its flexibility; and whilst the curve is still recent, and the patient young, if the weight of the head and shoulders be taken off, it will at once resume its straight direction. Thus, if the patient be lifted off the ground by raising her up with the hands under the axillæ, or if she be laid down on her face on a flat couch, the back will fall into a straight position, or may readily be made to do so by slight traction. After the affection has existed for some time, or if the patient have passed that age at which consolidation of the bones and ligaments is completed, the distortion will continue permanently, in whatever position she may be placed. This is not only owing to the deformity of the spine, but to the ribs, and ligamentous and muscular structures generally of the trunk, having become distorted, shortened, and fixed in their abnormal position.

Treatment.—The treatment of lateral curvature of the spine should be conducted on rational principles; and, when divested of the mystery with which some interested specialists have surrounded it, becomes simple enough. There are three principles of treatment that require to be carried out in these cases. The first is the improvement of the general health,—unless this be effected, nothing can be done; the second is, to strengthen the muscles of the spine; and the third, to relieve the spine as much as possible from the weight of the head, neck, and upper extremities.

The administration of some of the milder preparations of iron, with a course of aloëtics for the regulation of the uterine function, is of great moment; at the same time, a nourishing diet of animal food should be allowed, and the patient encouraged to take exercise in the open air. By these means the nutrition of the system will be improved, and the tone of the muscles restored. The muscular power may be more directly strengthened by having the back well sponged with salt or vinegar in cold water every morning, and methodically rubbed from top to bottom. The friction should be applied principally to the erector spinæ muscles and their prolongations on each side of the vertebral column, and may be done either with the naked hand, or with some slightly stimulating embrocation. At the same time, if the patient's strength will permit it, but not otherwise, the use of the hand-swing may be allowed, or calisthenic exercises practised, and swimming learnt; by it the back is straightened, and its muscles braced more effectually than in any other exercise; these exercises, however, should not be continued to the extent of inducing a feeling of fatigue or exhaustion. Whilst this plan is being persevered in, the patient should be made to lie recumbent for a few hours daily, sitting as little as possible and standing only when taking exercise. By these means, assiduously continued for some length of time, the muscles of the back may be strengthened, and increase of the deformity prevented; and in this way the slighter cases of lateral curvature, those in which there is a tendency to, rather than a full development of, the disease, may be cured. Should the focal length of the two eyes vary materially, this must be corrected by the use of proper glasses. All faulty habits must be corrected; one-handed games laid aside; in writing or drawing a sloping desk should be used, to which the child should sit squarely. If the girl rides, she should learn to sit alternately on the off and near sides.

In slight cases of lateral curvature, great evil may be occasioned and the deformity increased by the unnecessary employment of cumbersome machinery. The heavy apparatus that is often applied to growing girls overpowers and compresses, rather than supports and directs the imperfectly developed and still yielding skeleton. By the use of complicated machines the muscles of the back become weakened and atrophied from disuse; the pelvis is compressed and contracted; and those very evils are produced by the mechanician which it is the object of the Surgeon to avert or correct.

When the affection is further advanced, though the spine still continue flexible, if there be decided projection of the ribs on one side, and the shoulder and hip be prominent, with apparent difference in the length of the limbs, and much impairment of the general health, more decided measures of treatment must be had recourse to. In these cases, as in those just described, the constitutional powers must be carefully attended to on ordinary medical principles; iron, and good living, with fresh air, being the basis of the treatment. At the same time that we endeavour to improve the strength of the system in this way, and that of the muscles of the back, especially by cold bathing and frictions, it is essential to adopt means to take off the weight of the head and shoulders, and to prevent its continuing to keep up and to increase the deformity. This may be done in two ways: by keeping the patient in the recumbent position, or by allowing her to go about, wearing proper supports.

The **recumbent position** in the treatment of lateral curvature of the spine, though a valuable means as an adjunct to other measures, has been greatly abused, by being employed as an exclusive plan. This should not be, except when the patient is unable to stand or walk with comfort, as happens in extreme cases, when it may be necessary to confine her for a time to this position, until the proper muscular power has been restored by the systematic use of electricity or other means. These instances, however, are very rare; too much so to constitute the rule in the treatment. Whenever the recumbent position is employed, the prone seems to me far preferable to the supine, for reasons mentioned when speaking of angular curvature of the spine (p. 443); and the best couch for the purpose is certainly Verral's. The patient should be kept on this during the intervals of exercise, not being allowed to sit even at meals or to stand; she will very soon become accustomed to a position that at first appears constrained, and will, probably, speedily be able to sleep in it.

Mechanical Contrivances of all kinds should only be employed as a last resource. They are so contrived as to take the weight of the head, neck, and upper extremities off the weakened spine, are of very various forms, and have had much ingenuity expended on their construction. They all have three principal objects, however much their details may vary; viz.: 1, to form a broad basis of support round the pelvis, by means of a strong well-fitting band; 2, to carry off the weight of the head and upper extremities from the spine by means of lateral crutches, which transmit it to this band; and 3, to influence the convexities of the spinal curve by means of movable plates, acted upon by rack-and-pinion or screw power. The best of these mechanical contrivances for supporting the weight of the head and shoulders, is the apparatus represented in the accompanying woodcut (Fig. 625). By it the projection of the right shoulder may be gradually brought down, the left one raised, and the weight of the whole of the upper part of the body supported. By this contrivance alone, properly and carefully adjusted to the condition of the deformity, most patients may be treated without the necessity of any confinement whatever; the spine being by degrees restored to its proper direction by very gradually increasing the pressure and support of the instrument, at the same time that the general health is carefully attended to, and the patient has the benefit of good air. At first the instrument need be worn only during the day, but after a time it should be kept on at night as well. In long-standing and severe cases of lateral curvature of the spine, when its flexibility is lost, and the projection of the ribs has become permanent, a cure cannot be expected, nor can it be brought about by any means ; but the patient will derive great comfort and support from the use of this excellent instrument, and the increase of the disease may thus be prevented. Sayre's plaster jacket has been used for lateral curvature, but is now generally condemned, as it prevents movement completely, and thus increases the weakness of the muscles. A poro-plastic jacket, however, which can be removed for washing, rubbing and exercise may with advantage be used in the place of more costly and complicated apparatus.

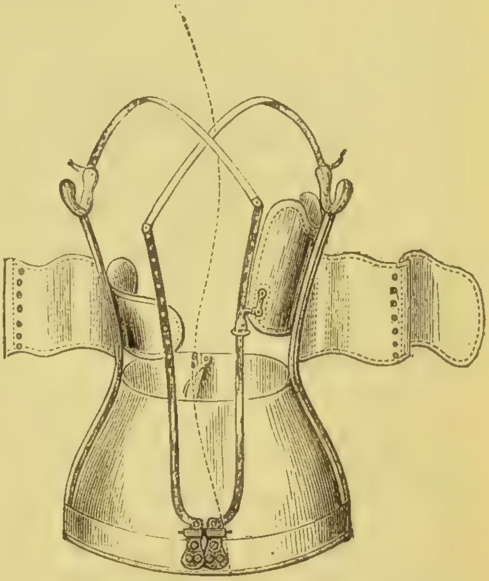


Fig. 625.—Spinal Support for Lateral Curvature.

The treatment of *Posterior Excurvation* of the spine, without caries or other organic disease of the vertebral column, is best conducted by the use of the instrument here figured (Fig. 626), which is constructed essentially on the same principles as that for lateral curvature, with the exception that the back-plate is so arranged as to press upon the projection, and thus gradually to bring it into proper position. In cases of kyphosis especially, attention should be directed to the sense of vision, and myopia or other impairments should be corrected by the use of glasses, the stoop being often dependent on near-sight.

In *Posterior Incurvation* the apparatus here figured (Fig. 627) will be found the most useful appliance. In fact, all these varieties of spinal curvature may be successfully remedied by instruments constructed on the most simple mechanical principles, if carefully attended to and carried out.

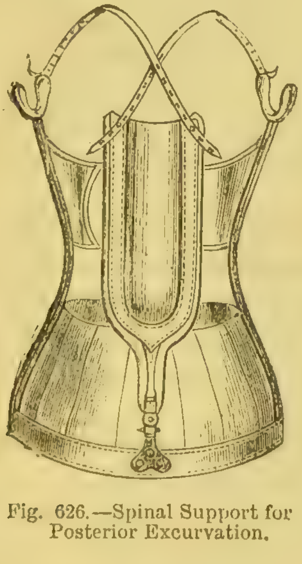


Fig. 626.—Spinal Support for Posterior Excurvation.

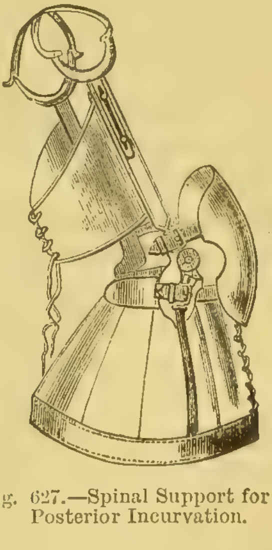


Fig. 627.—Spinal Support for Posterior Incurvation.

DEFORMITIES OF THE NECK AND LIMBS.

Various deformities, such as squint, wry-neck, and club-foot, are due to a disturbance of the normal equilibrium that exists between antagonistic muscles so that, by the paralysis of one set, or by the spasmodic action of the other, the proper balance of power is lost, and the limb or part deviates from the position that is natural to it, being drawn aside by the more powerful set of muscles. These deformities may be congenital, or they may be acquired.

The primary mischief is, in many cases, seated in the nervous system ; in others, but more rarely, in the muscular. The ligaments and bones become only secondarily altered in shape, being shortened or compressed on the side towards which the limb or part inclines or is drawn. Fasciæ also become shortened and tense, and the disused muscles are apt to become wasted, and flabby. The contracted muscle after a time may become permanently rigid and shortened.

CAUSES.—The causes of these deformities are very various ; but they may be referred to the following heads.

1. **Prolonged Abnormal Position** of a limb, as in an unreduced dislocation or an ankylosed joint, may lead to permanent deformity. It may be taken as a general pathological law that ligaments, fasciæ, and to a less extent muscles, if kept for a sufficient length of time in a continuously relaxed state, become shortened to accommodate themselves to the position in which they have been placed, and thus render the displacement which originally caused the relaxation permanent. The most marked example of this is seen in cases of neglected psoas abscess amongst the poor in which the patient has been allowed to lie in bed for months before death with the knees constantly flexed. After a time complete extension becomes impossible, and dissection proves that this is due to shortening of those ligaments that are relaxed in flexion. A similar shortening of ligaments or fasciæ may occur after fractures, if the parts be kept for too long a time in one position, more particularly if they be bound and matted together by the pressure of tight bandages. There is no danger however of such a condition being developed in the time ordinarily required for the treatment of a fracture. Some forms of congenital club-foot are believed to be due to a prolonged abnormal position of the limb during intra-uterine life.

2. **Contraction of inflammatory new growths or of tissues which have been infiltrated with inflammatory exudations,** is a fruitful cause of deformities. As examples may be mentioned, the contraction of the cicatrices of burns in any part of the body, acquired talipes equinus from contraction following a deep-seated abscess in the calf, and contracted knee or hip after inflammation of the joint.

3. **Derangement of the proper antagonistic action of certain groups of Muscles.**—This may arise from a variety of causes.

(A.) *The Position of the Limb* may give one group of muscles an advantage over their opponents ; thus, in disease of the knee, the flexed position gives the flexor muscles an advantage over the extensors, and we consequently find that the head of the tibia becomes after a time displaced to a greater or less degree backwards into the ham, merely by the tonic contraction of the muscles without any weakness or paralysis of their opponents.

(B.) *Paralysis or paresis of one group of muscles,* the contractility of their antagonists continuing normal, is a common cause of deformity, as the relative balance of action is destroyed, and the stronger muscles will pull the part over to their side. The causes of this condition may be in the muscles themselves, in the nerve supplying them, or in the central portions of the nervous system.

The muscle itself is seldom the seat of the primary lesion. G. V. Poore has pointed out that a single muscle or group of muscles may be weakened, and their contractility in response to electricity impaired by excessive use without sufficient intervals of rest. This is often accompanied by spasms of the opponent muscles, sometimes tonic, but more often clonic, and thus deformity may result. This is not however a common cause of actual deformity.

The conductivity of a motor nerve is frequently abolished by wound, injury, pressure of tumour, exposure to cold, or neuritis from other causes. A good example of the effects of lesion of a motor nerve in producing deformity may be seen in the peculiar condition of the hand and forearm, described at p. 597, Vol. I., as resulting from paralysis of the musculo-spiral nerve in certain fractures of the humerus. In paralysis of the facial nerve from cold the face is drawn to the sound side. Internal squint may result from paralysis of the sixth nerve from pressure upon it as it enters the orbit, the external rectus losing its power and the eye being drawn inwards by the action of its antagonist, the internal rectus.

Disease of the central nervous system, more especially of the spinal cord, is a frequent cause of deformity, which is very common in infancy and early childhood, as a consequence of Infantile Paralysis. This disease is now known to be due to inflammation of the anterior grey cornua of the cord. At first there is extensive paralysis, which gradually clears up as the acute stage passes off, often leaving merely a single group of muscles permanently powerless, as for instance, the tibialis anticus, and the extensors of the toes. As the result of this the foot becomes extended by the unopposed muscles of the calf, and one form of acquired club-foot is produced. Little has made the important observation that many cases of deformity in infants appear to be due to mischief inflicted on the base of the brain during protracted and instrumental labours.

Another example of deformity from disease of the central nervous system is the club-foot and occasionally club-hand also, met with in cases of encephalocele or spina bifida.

(c.) *Spasm of a muscle or group of muscles* also may give rise to deformity, the opponent muscles remaining perfect in their contractility, but being overbalanced by the continued contraction of their antagonists.

Spasm may be the result of direct irritation of the central nervous system. This would appear to be the case in some forms of squint. It may also be reflex, resulting from some peripheral irritation. This we commonly see happen in cases of contraction occurring from the cutting of teeth, the irritation of worms in the intestinal canal, in the so-called hysterical contractions from uterine irritation, &c. From all these various causes, contraction and consequent deformity may arise. In some cases deformity will cease after removal of the cause; but in other instances, in which it has been of long duration, the deformity will continue, owing to the muscles having fallen into a kind of rigid atrophy, being shortened and wasted.

4. When deformity has arisen in the lower extremity as a consequence of any of the above conditions, it becomes greatly aggravated by the *weight of*

the body acting on the deformed limb. This we see specially marked in old club-feet.

Treatment.—The *General Treatment* of deformity consists in removing the cause of the contraction in those cases in which it is dependent on central or peripheral disease or irritation that admits of remedy. Thus, if squinting arise from pressure upon the brain, the eye will resume its straight direction when the congested vessels are relieved, or the effused fluid absorbed ; or if a contraction of the hamstring muscles arises from the irritation of worms in the intestinal canal, a purgative dose may cure the affection.

Electricity is perhaps the most valuable agent we possess for the treatment of those deformities that arise from paralysis of one set of muscles allowing those that retain their healthy contractility to draw the parts over to their side. Thus, for instance, if the muscles supplied by the external popliteal nerve, the tibialis anticus, the extensors of the toes, and the peronei—are paralysed, so that the muscles of the calf, the tibialis posticus, and the flexors of the toes draw the foot into the position of Talipes Equinus and Varus, the electricity must be applied to the former group of muscles. The continuous current will be found the most efficient, faradization being of but little use if degenerative changes have commenced in the paralysed muscles. In the case just described the sponge connected with the positive pole should be tied over the external popliteal nerve behind the head of the fibula, and the negative sponge applied freely over the paralysed muscles till the skin becomes slightly reddened.*

Friction properly applied forms a useful adjunct to electricity, and great care must be taken to keep the limb warm by proper clothing, without which the other treatment will be of little avail.

In many cases, the contraction may be slowly but very effectually overcome by the use of suitable apparatus, having a constant elastic or tensive action kept up by means of bands of vulcanized india-rubber or steel springs. The details of these various appliances, though belonging to the department of the instrument-maker, cannot be too carefully studied by the Surgeon, who, after all, in order to guide and control their action, must be thoroughly conversant with the mechanical principles involved in their construction. In many of the slighter and less chronic cases, the deformity may be remedied by the employment of these milder means, singly or conjoined ; but in those which are congenital or more permanent, the *Division of the Tendons* at fault is the best mode of restoring the natural condition of the part. The *orthopædic* department of surgery owes, in a great measure, its existence to Delpech and Stromeyer, and its perfection to Little, Tamplin, and Adams.

Tenotomy.—By tenotomy, as at present practised, is meant the subcutaneous division of a contracted tendon by means of a narrow-bladed knife (Figs. 628, 629, 630) introduced obliquely through a puncture by its side. In doing this, it should be borne in mind that the normal anatomical relations of parts are often a good deal disturbed in cases of deformity : and thus tendons may be approximated to arteries and nerves, from which, in the healthy condition of the limb, they are widely separated.

In the operation of tenotomy the knife may be used in one of two ways. In the majority of cases the tendon may be most conveniently divided by introducing the blade beneath it sideways, and then turning the edge against it, and scratching through it by a kind of fine sawing movement, whilst it is made tense by an assistant. The knife should, if possible, be used as a lever, the back being firmly pressed against some resisting point. If the blade be pressed directly forwards, there is some danger that it may suddenly cut through the skin as the tendon gives way. The second way is to pass the tenotome superficially to the tendon between it and the skin, and then to turn the edge against it whilst it is made tight by an assistant. By this plan the danger of wounding the skin is avoided. A drop or two only of blood is lost in the operation ; and, as the divided tendon retracts with a kind of snap, a gap will be left between the two ends, from half an inch to an inch in width, according to the previous amount of tension in the part. If the muscles have been contracted for some years, it will commonly be found that the fasciæ in the neighbourhood of the tendon have become rigid and unyielding, forming cords or bands stretching across from the side of the gap. If these be very tense, they may be divided in the same way ; but in many instances it will be found, after the lapse of a short time, that they will yield by stretching, and consequently will not require division. After the section has been made, the small puncture should be closed with a pad of lint and a strip of plaster, or some cotton-wool and collodion. The admission of air should be carefully guarded against, lest it carry with it impurities which might give rise to inflammation and suppuration. For the same reason the knife should be cleaned in carbolic lotion and the skin washed with the same before the operation. Even without any antiseptic precautions, however, it is very rarely that suppuration follows subcutaneous tenotomy, if performed with ordinary care. After tenotomy the part should be simply bandaged and either left without any apparatus, or supported by a splint in the same position that it occupied before the tendon was cut, no attempt at extension being made for three or four days. At the expiration of this time repair will have commenced, and then proper mechanical contrivances may be adjusted for gradually restoring the normal position of the limb or part.

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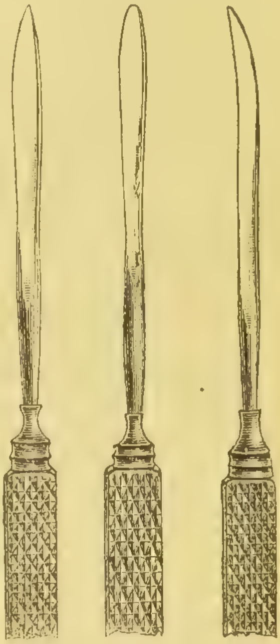
* For details of the treatment of paralysed muscles by electricity, I must refer the reader to special works on the subject, especially the selection by G. V. Poore from the Works of Duchenne (of Boulogne), published by the New Sydenham Society in 1884.


Figs. 628, 629, 630.—Tenotomes.

Sayre adopts a different method. He makes extension immediately after the division of tendons and fasciæ, and I have seen excellent results follow this practice. It is not, however, applicable in all cases, as, in some instances of talipes of old standing, the contraction appears to exist in the ligaments as well as in the more superficial structures. In such cases considerable resistance will be offered, and long-continued extension be required.

The mode of **Repair in Divided Tendons** has given rise to some controversy, there being two theories with regard to the process. According to one, the granulation-tissue between the divided and retracted ends gradually undergoes a process of contraction, analogous to what takes place in the cicatrix of a burn, so as to cause approximation of the cut ends of the tendon at the expense of the muscle, which becomes partially lengthened, until at last a transverse linear cicatrix merely is left at the line of section. Adams has, however, conclusively shown that this theory is erroneous, and that repair is effected by the formation of vascular granulation-tissue between the cut ends, chiefly from the sheath and soft parts around; that this undergoes gradual development into fibrous tissue; and that the tendon is actually lengthened and remains permanently so, though perhaps not to the full extent of the gap at first existing between its ends. The new material eventually resembles the normal structure of tendon so closely that the microscope fails to detect any appreciable difference, and it can be distinguished only by its more translucent appearance from the old tendon.

In cases of congenital malformation, the question frequently arises as to whether tenotomy should be performed in early infancy, or delayed to a more advanced age. As a general rule I think that, if operation will certainly be necessary, it should not be delayed; it is not more difficult at an early period of life than at any other, no danger attends it, and when performed during infancy, there is a far less chance of the deformity being permanent, than if the operation be delayed for some years. But it must be remembered that many slight deformities and contractions in infants may be removed without operation, by attention to proper mechanical and hygienic means. The Surgeon should not, therefore, be too ready to operate in slight cases at tender ages.

DEFORMITIES AFFECTING THE FACE AND NECK.

Wry-neck, Torticollis or **Caput Obstipum,** arises from spasm of one of the sterno-mastoid muscles; the head being drawn to the affected side. On close examination in wry-neck, it will be found that there is a triple displacement of the head, which is drawn downwards, rotated from the affected side, and inclined laterally towards it. The features lose their symmetry. The half of the face, and even of the head, on the affected side, becomes less perfectly developed; and the true lines of the eyebrows, eyes, and mouth become displaced and lowered.

In torticollis, the affected sterno-cleido-mastoid will be found hard, defined, and shortened; sometimes both divisions of the muscle are equally tense, standing out in strong relief, so as to look almost like two distinct muscles. In other cases, one division, and then most usually the sternal, is chiefly affected. After a time the cervical vertebræ participate in and maintain the displacement, becoming rotated on their axes and curved. Eventually the whole spinal column shares in the displacement, and lateral curvature sets in. The deeper muscles also become shortened, and the anterior margin and clavicular attachment of the trapezius will often be found tense and preternaturally defined.

Causes.—Wry-neck appears to be occasionally congenital: more frequently it is acquired, coming on in childhood after measles or scarlatina, usually as a consequence of inflamed cervical glands, and is then due to the position instinctively assumed by the head in order to relax muscular tension on the inflamed side of the neck. It not unfrequently commences with an ordinary stiff neck from cold. In other cases, again, it is purely spasmodic, the tension of the muscle varying at different times, disappearing when the child is anæsthetized, and being overcome by gentle traction. In these cases the spinal accessory nerve is probably at fault, and it is owing to irritation of it that the sterno-mastoid and trapezius muscles take on a spasmodic action. In spasm of both sterno-mastoids the head is thrown forwards, the muscles projecting in great relief. In these cases, the disease may be found to have had a rheumatic origin. Deformity in this situation may occur also from diseased cervical vertebræ, or from the traction of the cicatrix of a burn. The conditions here, however, are peculiar, depending upon causes that are irrespective of the state of the muscles, which are not tense, and may thus readily be distinguished from the true form of the disease produced by the causes above mentioned.

Treatment.—The treatment of torticollis arising from permanent shortening of one of the sterno-mastoids, which is the common form of the affection, may best be conducted by dividing the inferior attachment of the muscle, and thus allowing the head to regain its proper position. The division of the muscle is a somewhat delicate operation, on account of the important structures that lie immediately behind it. By making the incision, however, through it, from behind forwards, close to the sternum and along the clavicle, there can, if ordinary care be employed, be little risk of doing any damage, as these bones carry the lower attachment of the muscle forwards, and separate it from subjacent parts. The tension also, into which it is thrown by its spasm, draws it away from the carotid sheath. In several instances in which I have had occasion to perform this operation, no difficulty whatever has been experienced in dividing the sternal attachment of the muscle, which is usually very tense and prominent, by making a puncture on the inner side of the tendon, pushing a narrow director behind the muscle, drawing the latter forwards, and then passing an ordinary tenotome behind the tendon, with its flat side towards it, just in front of the upper margin of the sternum, and cutting forwards, whilst the muscle is put well upon the stretch. In dividing the clavicular insertion, the safest plan, I think, consists in making a puncture with a scalpel upon and down to the clavicle in the cellular space which lies between the two attachments of the muscle, and then pushing a long, blunt-pointed, narrow-bladed tenotome beneath the insertion of the muscle, dividing this in a direction forwards. In this situation also the director may be used, unless the parts are very tense. Care must be taken of the external jugular vein at the outer edge of the muscle. Should this vessel run inconveniently close to the edge, the safer plan is to begin the operation from the outer side, making the first puncture here. After division of the tendon, the deep fascia of the neck will sometimes be found stretching across in firm and tense bands; these, however, had better not be interfered with, as they will yield in time, and much risk of injuring the subclavian and carotid vessels would attend any attempt at their division. Nor should the edge of the knife ever be turned inwards. Care must be taken to divide the muscle completely, but not to carry the incision too freely or deeply. I have heard of more than one case in which, from want of due precaution, abundant hæmorrhage occurred, and of three in which fatal results followed the operation.

After the operation, the position of the head must be gradually rectified by proper apparatus. The best instrument for this purpose is the one invented by Bigg, and here figured (Fig 631). It consists of a pelvic band, a vertebral stem, and arm-pieces, the object of which is to secure a firm basis of support to the neck-lever (1), and the maxillary lever (2). The neck-lever passes round the head, and takes its bearing against the temporal bone on the side towards which the head is deflected. The maxillary lever acts against the lower jaw on the opposite side—that which is turned up. By means of a ratchet-joint, the neck-lever, the action of which is vertical, turns the head from the side to which it is deflected, whilst the maxillary lever, acting horizontally, rotates the head on its axis. By the combined action of these two forces the head is restored to its vertical position, and the chin replaced in the mesial line. In this way the curvature of the cervical vertebræ may gradually be corrected; should it however, have existed for a considerable time, it may have assumed a permanent character, and a twist in the neck will continue for life. If the operation be not delayed until too late in life, the features will gradually regain their symmetry.

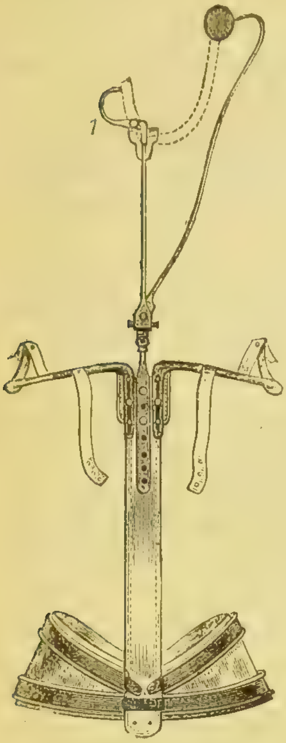


Fig. 631.—Bigg's Apparatus for Wry-Neck.

The stretching and division of the spinal accessory nerve have been practised, but not with any benefit. When wry-neck is secondary to disease of the cervical vertebræ, little can be done beyond maintaining the spinal column in as steady and fixed a position as possible, by means of mechanical support (see p. 821, Vol. I.).

In those cases in which the wry-neck appears to be dependent rather on paralysis of one sterno-mastoid, than on spasm of the other, electricity, and the application of strychnine to a blistered surface over the muscle, will be found most useful.

DEFORMITIES OF THE ARM AND HAND.

Contraction of the Arm is not of very common occurrence, except as the result of burns. I have, however, met with four distinct forms of contraction of the forearm.

1. There may be ankylosis of the elbow-joint, the forearm being bent at a right angle with the arm, the result of disease in or around the articulation. If the ankylosis be fibrous, and the muscles strong and firm, a very useful limb may be restored by breaking down adhesions, under chloroform, by forcible flexion and extension, and then using passive motion, friction, and douches. Should the muscles be very flaccid and wasted, forcible extension may leave a permanently weakened limb, over which the patient has lost the power of flexion. In such cases I have found gradual extension, made by means of an angular splint, acted upon by a ratchet-apparatus, the safest means of restoring the utility of the arm. If the ankylosis be osseous, the bones should be resected, a wedge-shaped piece being sawn out, and a false joint allowed to form.

2. The biceps may, by its contraction, occasion a permanent flexion of the arm. This contraction of the biceps may be hysterical, rheumatic, or syphilitic. The syphilitic form may be due to gummatous infiltration of the muscle. When it is hysterical, occurring in young women, it requires the ordinary constitutional treatment of hysteria; should this fail in removing it,

extension may be made, under chloroform, and the arm kept in the straight position for a time. When it is syphilitic the ordinary treatment of syphilis may produce a cure. When of organic character, and permanent, section of the tendon and its aponeurosis may be practised, due care being taken of the artery and nerve. This operation is most safely done by introducing the tenotome to the inner side of the tendon, slipping it under, and cutting upwards and outwards; the artery being guarded and pushed to the inner side by the pressure of the left forefinger.

3. The forearm may be forcibly pronated and flexed as the result of chronic inflammation of the radio-humeral articulation. Here forcible supination and extension, under chloroform, is the best remedy.

4. The forearm may be bent on the arm in consequence of the contraction of the cicatrix of a burn along the inside of the limb. In this case, the plastic operation described at page 395, Vol. I., must be practised.

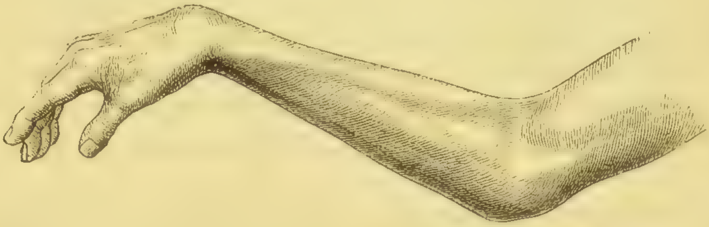


Fig. 632.—Contraction of Supinators of Forearm and Extensors of the Hand.

Ankylosis of the Arm in the Straight Position is a condition of very serious inconvenience, the limb being almost useless for all ordinary purposes of life. In cases of this kind, the treatment to be adopted must depend upon whether the ankylosis be fibrous or osseous. If it be fibrous, however firm, the forearm may always readily be brought into a rectangular position by flexion under chloroform, and the mobility of the joint may then be improved or restored by passive motion, friction, and douches. If it be osseous, a wedge of bone must be removed, and the case treated as an ordinary instance of excision of the elbow, with a view of establishing a false joint.

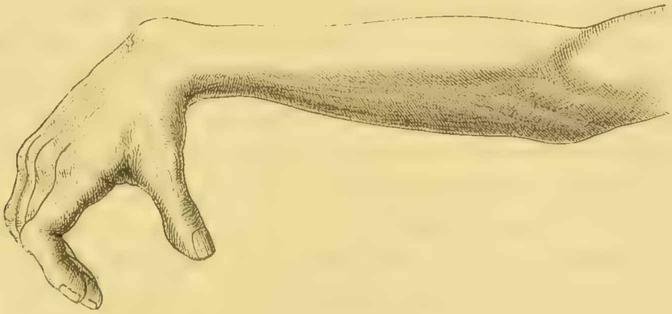


Fig. 633.—Contraction of Flexors and Pronators of the Hand.

Acquired Contraction of the Muscles of the Forearm implicating the Hand is occasionally met with in adults. I have seen it in two opposite conditions; that of forcible extension (Fig. 632), and that of forcible flexion and pronation (Fig. 633). In both instances it appeared to have been the result of excessive use of certain muscles; in the first case in wringing out clothes, in the other in cutting with very heavy shears. In the case of flexion and pronation, it was interesting to observe that, when the fingers were extended, the wrist became flexed, and when the wrist was extended the fingers became bent in. In these cases change of occupation, friction, and galvanism, with the use of a straight splint, were advantageously resorted to, a cure being eventually effected.

Paralysis of the Extensors and Supinators, owing to injury of the musculo-spiral nerve consequent on fracture of the humerus, has been described at p. 596, Vol. I.

Club-hand.—A deformity resembling club-foot is occasionally, though rarely, met with in the hand. The contraction may occur in two directions; either in the sense of preternatural flexion, or in that of abnormal extension of the member. It has been described by Cruveilhier, Voillermier, and Smith of Dublin. In most of the cases that have been met with, there was a certain amount of deformity of the lower end of the radius, with congenital dislocation of the wrist; and in Smith's case there was an accessory semilunar bone in the carpus. In other cases it has been caused by congenital absence of the radius. Little, if anything, can be done by surgery for the relief of this deformity.

Arthritis Deformans or **Rheumatoid Arthritis** of the hand is a common affection. In this condition, the fingers which are thickened and stiffened are partially bent towards the palm, and at the same time turned towards the ulnar side. The articulations are swollen, and in the earlier stages painful. The disease rarely occurs before middle age. It is more common in elderly people, and especially those of the labouring class, whose hands have been much exposed to the weather, with the fingers bent as in holding reins or agricultural implements. The deformity is permanent and incurable.

Dupuytren's Contraction of the Fingers.—One or more fingers may be bent in consequence of injury of the flexor tendons; the skin and fascial structures of the palm remaining sound with the exception of some cicatricial tissue. Such a contraction is incurable, as a portion of the tendon has probably sloughed away. In the true digital contraction, commonly called *Dupuytren's contraction*, its pathology having been pointed out by that great Surgeon in 1832, the tendons and their sheaths are unaffected, the deformity being due to changes taking place in the fascial structures outside them. Most commonly this commences in the little finger, and thence gradually extends to the ring and middle fingers, which become so forcibly and firmly flexed, that their extension is not practicable. This deformity is very rare in females, and is most commonly met with in males after middle life. It results usually from frequent and continued pressure on the palm of the hand, as in leaning on a round-ended stick in walking, or in those trades in which an instrument is pressed into the hollow of the hand. It occurs often without any apparent exciting cause. In such cases I have always found it associated with a rheumatic or gouty diathesis. On examining the contracted fingers, projecting ridges will be felt extending from the palm to the anterior aspects; and on endeavouring to straighten them, these ridges will be found to become stretched, and the palmar fascia to be rendered tense. The skin covering these fascial ridges is at first free, but after a time becomes adherent to them. So firmly are the fingers contracted, that by no effort can they be extended.

Pathology.—Dupuytren found on dissecting a hand which was the seat of this disease, that after the removal of the skin, which was loose and flaccid, the contraction continued as before, and this, therefore, could not be its seat; that the palmar fascia, which was exposed, was tense and shortened, whilst from the lower aspect some cord-like prolongations passed up by the side of the fingers; and that, when these were divided, the contraction was immediately removed, the tendons, the bones, and the joints being perfectly sound. He considered these fibrous cords to be digital prolongations of the palmar fascia, and consequently looked upon this membrane as the seat of the disease. Goyrand, who has carefully dissected hands affected in this way, states that these fibrous cords, which he looks upon as the seat of the affection, are not prolongations of the palmar fascia, but are fibrous structures that extend from its superficial aspect to the sheaths of the flexor tendons, into which they are inserted opposite the second phalanx; being formed by hypertrophy of bands of subcutaneous connective tissue which naturally exist in this situation. However this may be, the fact remains certain that the flexor tendons have nothing to do with this special form of finger contraction, but that it is due entirely to fibrous cords from the digital divisions of the palmar fascia; and as Adams has pointed out, the insertion of these digital prolongations of the fascia into the periosteum of the second phalanx readily explains the drawing down of that bone.

The Diagnosis of cases of digital contraction, so far as the deformity is concerned, is obvious, and requires no comment; so far as the cause is concerned, it is not so easy. Is it tendinous or fascial? When *tendinous*, the contracted tendon can be followed up to and above the wrist as a tense cord; the palmar structures being healthy. When *fascial*, the tendon cannot be clearly defined, but the palmar structures are dense, thickened, and incorporated together, forming distinct ridges and sulci.

This true digital contraction must not be confounded with that "arthritis deformans" which often distorts the weather-beaten hands of labouring men and sailors. In these cases all the fingers are bent inwards, and more or less twisted to the ulnar side, so that the hand presents a claw-like appearance, the mischief evidently affecting the joints.

Treatment.—The treatment of digital contractions is purely mechanical and operative. The progress of the disease may be retarded, and some benefit obtained by the use of finger-splints applied to the dorsal aspect, and provided with elastic tractors. The kind of operation must be determined by the pathological cause of the disease. If the case be one of contraction of the flexor muscle and tendon tenotomy may be performed, but in Dupuytren's contraction the tendon and its sheath must not be touched, but the contracted structures outside them must be cut across.

Adams, recognizing the true pathology of this affection (Fig. 634), has devised a successful means of remedying it by subcutaneous operation. He justly deprecates in such cases all operation by open wound. The plan consists in making multiple subcutaneous divisions of the fascia and its digital prolongations. For this purpose he uses the smallest possible tenotome—little larger than a cataract-needle; with this instrument about four subcutaneous incisions are made to each finger, not operating on more than one or two fingers at a time. The first puncture is made in the palm just above the transverse flexion-crease at a point where the skin is least adherent. By the second puncture, the same cord should be divided between the flexion-crease and the web of the fingers. The third and fourth punctures should be made so as to divide the digital prolongations of the fascia. Immediate extension is then made, and the fingers kept straight on a padded metal splint.

In performing this operation the Surgeon must be careful not to carry his incisions or punctures too deeply into the palm, lest the superficial palmar arch or one of its branches be divided. The guide to the commencement of the digital prolongations from the palmar fascia is the *transverse flexion-fold* in the palm. This—as Adams has pointed out—corresponds exactly with the line of the metacarpo-phalangeal articulations, and is of course well in advance of the superficial palmar arch. By keeping the highest incisions near to this line, no danger to this artery need be feared. Should it be found to be impossible to straighten the fingers with such limited incisions, or should the skin be firmly adherent to the subjacent fibrous band, it has been recommended to make a crucial incision through the skin, to turn the flap back, divide or dissect off the fascial bands from the sheaths of the tendons, and straighten the fingers. As the flexor tendons are not primarily affected, they must not be divided. After the operation, the hand should be placed on a digitated splint and the fingers kept extended. This mode of treatment can only be attempted as a last resource in a useless hand, as the prospect of success is not great.

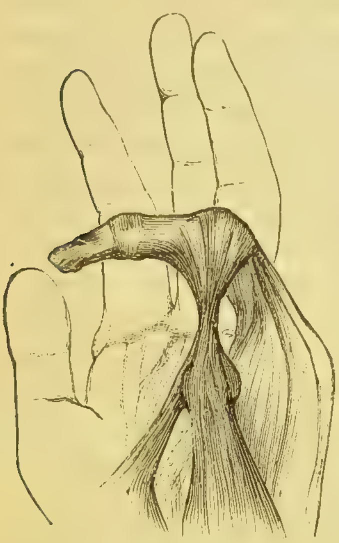


Fig. 634.—Dupuytren's Contraction (after Adams).

Contraction or bend of the finger backwards is of very rare occurrence. I have seen only one such case in a lady in whom the little finger of one hand had a crescentic curve backwards, the ring-finger was also slightly affected. This condition, which was permanent for many years, obstinately resisting all treatment, mechanical and constitutional, appeared to be due to chronic neuritis of the cords of the brachial plexus, consequent on a fall on the back of the head and neck.

Congenital Deformities of the Fingers and Hand are frequently met with and assume very various forms, the chief of which can only be briefly alluded to here.

1. **Congenital Hypertrophy of the Fingers** or **Macrodactylism** is a rare condition in which one or more digits grow to a size altogether out of proportion to the rest of the hand, though still maintaining more or less accurately their normal form. Two or three fingers are commonly affected. Attempts have been made to reduce and arrest the growth by pressure but without success. If the large digits are useless, they may be amputated.

2. **Supernumerary Digits** or **Polydactylism** form the most common deformity of the hand. The supernumerary digit is always either at the radial or ulnar side of the hand, and in three-fifths of the cases it is in the latter situation. The degree of development of the digit varies greatly. It may be so perfect that it appears to be simply a continuation of the natural series, there being six complete digits instead of five; and Morand describes a hand having a thumb and six well-formed though somewhat shortened fingers. More commonly the supernumerary digit is far from perfect. The

presence of a metacarpal bone is rare, but three well-formed phalanges are not uncommonly found attached by a lateral articulation to the inner side of the head of the fifth metacarpal bone. In the least perfect form the finger is represented by a small fleshy lump commonly containing a small central mass of cartilage, and always provided with a rudimentary nail. It is attached to the base of the first phalanx of the little finger by a narrow pedicle. Various intermediate forms are also met with. A supernumerary thumb may be distinctly separate, containing usually two small deformed phalanges, or it may be more or less completely fused with the normal digit, forming a wide mass with a double nail at the end, In other cases the thumb is merely bifid, the last phalanx only being double. All these varieties of deformity of the fingers are more or less hereditary. They may in most cases very easily be removed by operation, which is simple and perfectly safe, the supernumerary finger being disarticulated at its base. It is better to do this at as early an age as possible ; no good can possibly come of delay.

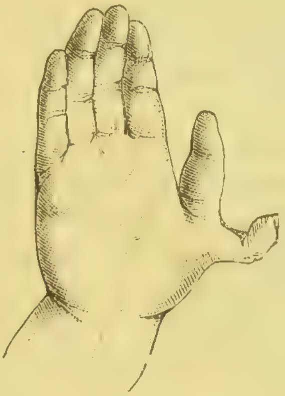


Fig. 635.—Supernumerary Thumb.

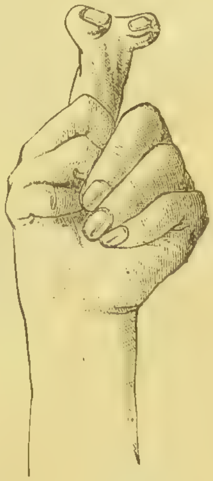


Fig. 636.– Apparent Fusion of Hands.

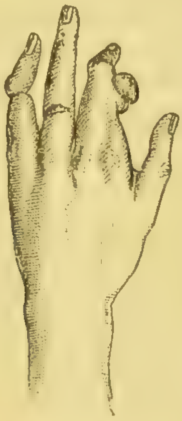


Fig. 637.—Left Hand.

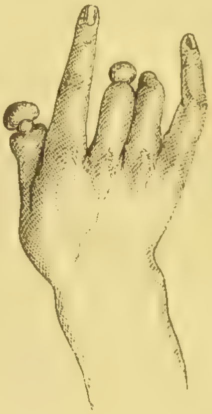


Fig. 638.—Right Hand.

Arrest of Development of Fingers.

In some rare cases, as in that from which the annexed drawing (Fig. 636) was taken, two hands may appear to be fused into one. In these no operation is possible.

3. **Congenital Want of Development of the Fingers** or **Microdactylism** is a less common deformity. In the extreme forms of this all the fingers may be wanting except the thumb and little finger, which may be approximated to each other like the claws of a crab, the hand being deeply cleft in the situation of the missing fingers.

5. **Partial Congenital Amputation** or **Dactylolysis** is another rare deformity. The accompanying drawings (Figs. 637 and 638) are correct representations of a remarkable deformity of the hands in a child that was under my care some years ago. The fingers appear to have suffered in some instances complete, in others partial, amputation in utero. They are marked by deep transverse sulci ; others are shortened, and terminate in rounded nodules, with a narrow pedicle connecting them with the proximal phalanx.

Webbing of the Fingers or **Syndactylism** is occasionally met with. In this condition a cutaneous septum unites contiguous fingers. Sometimes the malformation is confined to one digital interspace, and then it is usually that between the index and middle fingers. In other cases it occupies two or all three interspaces. The web is a tolerably thick septum of skin, narrow at the base, broader above. It may extend the whole length of the fingers, or only a portion. The web does not interfere with the movements of the fingers in flexion or extension.

This deformity is not easily remedied by operation. It would seem extremely simple to divide the web and to keep the fingers apart while the raw surfaces are healing, but experience has shown that this treatment leaves the patient little better than before the operation, as gradual union of the raw surfaces advances from the angle in spite of all that can be done to prevent it. To overcome this difficulty it has been suggested to make a puncture through the web at the base of the space between the fingers, and to pass through this a piece of glass rod or metal, which may be worn until the wound thus made is completely covered by epithelium. When this healing is complete, the web may be slit up without risk of re-union proceeding from the angle between the fingers.

When the septum is sufficiently thick, the following operation, invented by Didot of Liège, may be advantageously practised. Supposing the index and middle fingers to be webbed, the following would be the procedure to be adopted, which is of course equally applicable to any of the other fingers : 1. The Surgeon makes an incision along the median line of the palmar aspect of the index finger, extending the whole length of the web. 2. Two small transverse incisions are now made at the upper and lower ends of this longitudinal incision, extending from it to the ends of the web. 3. The rectangular flap thus defined is dissected back as thick as possible, so that its back corresponds to the mid-line of the web. 4. A corresponding longitudinal incision is now made along the dorsal surface of the middle finger, but comes rather further down on the hand. The two transverse incisions at its upper and lower ends are next made ; the flap thus defined is dissected back, and when the knife reaches the mid-line of the web the two fingers will be found to be separated. 5. The next and last step of the operation is to wrap each flap round the raw surface of the finger to which it continues to be attached, and to fix it in position by a sufficient number of horsehair or fine catgut stitches. Thus the raw surface on the index finger will be covered by the flap taken from the dorsum of the middle and *vice versâ*, as is seen in the accompanying diagram (Fig. 639).

In the accompanying cut (Fig. 640), transverse sections of the fingers are shown. The operation should not be undertaken at too early an age, as the small size of the parts makes it difficult to do it efficiently. It is doubtful also if the result in after-life is always satisfactory. I have known of a case in which the scars in the site of the divided webs seemed, by contraction and want of growth, to have led to deformity of the fingers even more crippling than the original webbing, and ultimately necessitating partial amputation of one finger which was hopelessly distorted and flexed into the palm. If two fingers only are webbed, they may be left until the hand is fully grown before operation.

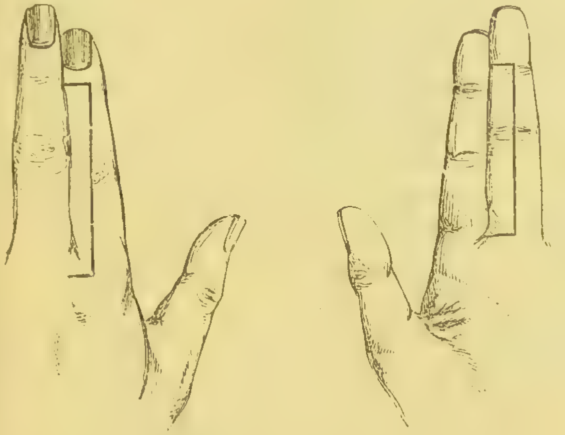


Fig. 639.—Diagram of Flaps. Operation for Webbed Finger, with thick Septum.

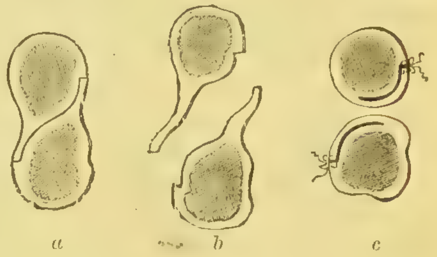


Fig. 640.—*a*. The lines of the two incisions uniting, so as to divide the Web and leave a Flap on each side. *b*. The Flaps detached from the opposite Fingers to those to which they are adherent. *c*. The Flaps applied to the Fingers, and covering in the raw and exposed surfaces.

DEFORMITIES OF THE LOWER LIMB.

Ankylosis of the Hip has been already described (p. 463), and **Congenital Dislocation** (Vol. I., p. 662).

DEFORMITIES OF THE LEG AND FOOT.

Knock-knee.—The deformity termed **Genu Valgum, Knock** or **X-Knee**, usually affects both extremities, though it is generally more fully developed in one than in the other. In it the knee forms the apex of a triangle, the base of which would be represented by a line drawn from the trochanter to the outer ankle. Knock-knee arises at two periods of life; first, during early childhood, when it is usually the result of rickets, and is most frequently conjoined with some curvature of the bones of the leg; and secondly, about puberty, when it is due to relaxation of the ligaments, and is frequently the result of carrying heavy weights. At this period it is often conjoined with weak ankles and splay-foot. In many cases the flat and everted foot is probably the primary affection. Bock states that out of 221 cases which he examined, 17 originated about the period of the first dentition, and 200 between that age and the 15th or 18th year. Some occupations are said to predispose to it, smiths being especially liable to the deformity. In whatever way knock-knee arises there is relaxation or stretching of the internal lateral ligament; the biceps, the external lateral ligament, and often the vastus externus are tense; and the patella is thrown outwards. In cases which arise directly from weakness and relaxation of the ligaments, Little states that a distinct gap, often of considerable width, may be felt between the inner side of the head of the tibia and the femur. From an early period in the rickety form, and at a later stage in cases of simple relaxation of the ligaments, the bones become altered in form. The internal condyle is elongated, sometimes, according to Macewen, to the extent of an inch. It is evident that in knock-knee the pressure in standing would be somewhat lessened on the inner side, the weight being unduly thrown upon the outer condyle. It is believed that as the result of this the growth of the outer condyle is arrested, and that of the inner is exaggerated. The lengthening of the inner condyle is not accompanied by a corresponding increase in its antero-posterior diameter, consequently when the knee is flexed the deformity disappears. In some cases the lowering of the inner condyle is due to a rickety curve in the femur immediately above the articular end. In extreme cases of knock-knee the joint is often capable of some degree of over-extension, the leg at the same time rotating outwards.

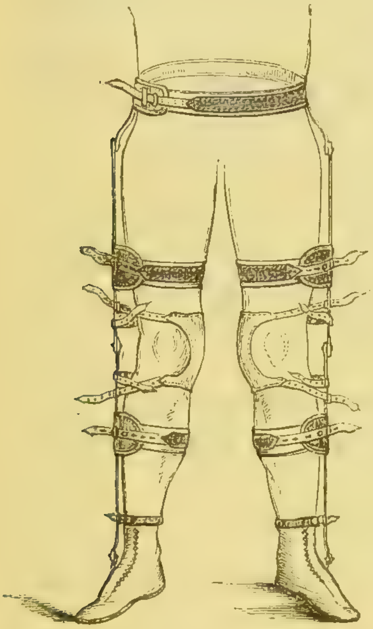


Fig. 641.—Apparatus for Knock-knee.

Treatment.—If seen in the earliest stage the feet should be examined, as much benefit or even a cure of the deformity of the knee may result from proper treatment directed to the correction of splay-foot. If the deformity in the knee is more marked, but still not extreme, the treatment consists in applying an apparatus consisting of a well-padded iron stem along the outside of the leg and thigh; this must extend from the trochanter to the outer ankle, being fixed to a pelvic band at the upper part, and into a boot below (Fig. 641). Where it corresponds to the knee it should be provided with a hinge, and should have a broad well-padded strap passing over the inner side of the joint, and attached by buckles to the stem, in such a way that by tightening these the knee may be drawn outwards. This apparatus should be constantly worn for many months; and, if properly adapted, may effect a cure.

When the deformity is of old-standing, and any attempt to correct it causes marked tension of the parts about the outer side of the joint, it has been recommended to divide the biceps tendon subcutaneously, care being taken not to injure the external popliteal nerve. This treatment, however, cannot be of much service, as in all well-marked cases the persistence of the deformity is due to the alteration above described in the bones.

In those cases in which the alteration in the bones is such that there is no hope of restoring the limb to its natural position by the simple means above described, the patient must be submitted to some operative procedure, or left to endure his deformity unrelieved.

During the last few years numerous methods have been devised with the object of correcting the deformity. The simplest of these is that of Delore of

Lyons. It consists simply in forcibly straightening the limb; the leg being extended, the Surgeon places his knee against the prominent inner condyle and grasping the ankle in one hand and the upper part of the thigh in the other, he gradually applies sufficient force to bring the limb straight. He continues the force from five minutes to half an hour, till the object is attained. The limb at last yields, a sensation of something tearing being felt. Delore states that the lower epiphysis of the femur is separated, but what actually takes place is somewhat uncertain, and must be left to chance. This method of treatment has been very successful in its inventor's hands, but in this country it has not yielded results equal to those obtained by antiseptic osteotomy.

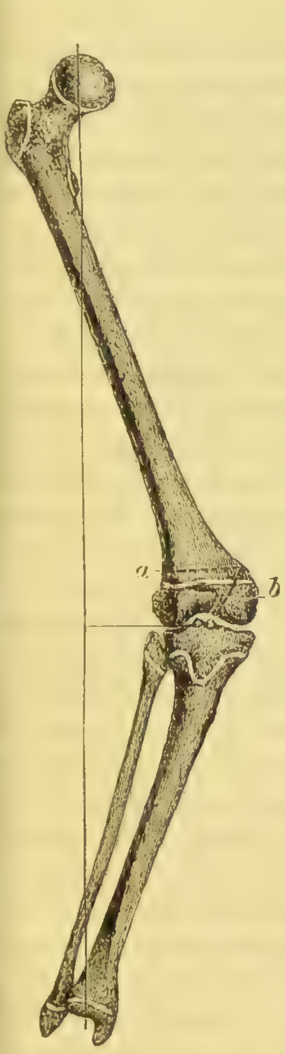


Fig. 642.—Knock-knee: *a*, line of division in Macewen's operation; *b*, in Ogston's operation.

Antiseptic osteotomy has for its object the restoration of the lengthened inner condyle to its normal level. It is impossible here to do more than mention many of the methods that have been employed with this object. In 1875, Annandale opened the joint and removed the prominent portion of the inner condyle with the saw. This bold operation was completely successful, but since the introduction of simpler methods it has not been repeated. In 1876 Ogston performed, for the first time, the operation of sawing off the inner condyle obliquely by means of an Adams's saw (Fig. 607), introduced through a puncture made in the skin above the inner condyle. In 1878 Macewen modified the operation by removing a wedge-shaped piece of bone in the line of Ogston's saw cut, but without penetrating so deeply as the articular cartilage, and Reeves at the same time suggested dividing the condyle with a chisel stopping just short of the cartilage. In 1878 Barwell, regarding the deformity not merely as a lengthening of the inner condyle, but as an obliquity of the whole lower epiphysis, cut through the femur with a chisel a little above the epiphysis from the outer side, and subsequently after some weeks divided the tibia and fibula in the same way about one inch below the articular surfaces. Lastly, Macewen introduced the method of dividing the femur only, immediately above the epiphysis, and, at the present time, this method is almost universally adopted in preference to all others. It has the great advantage of being simple and easy of performance, free from danger, and of not implicating either the epiphysis or the joint. The operation is thus performed. The limb should be laid fully extended on its outer side on bag of wet sand. A sharp-pointed scalpel is then introduced on the inside of

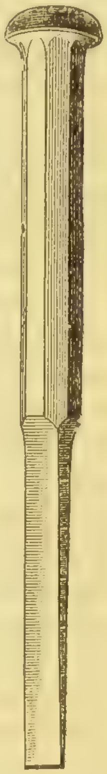


Fig. 643. — Macewen's osteotome.

the thigh, "at a point where the two following lines meet,—one drawn transversely a finger-breadth above the superior tip of the external condyle and a longitudinal one drawn half an inch in front of the adductor magnus tendon." The incision is made vertically upwards, and should be about three-quarters of an inch in length, being slightly longer than the breadth of the chisel to be used. The scalpel must be carried directly down to the bone, and the osteotome must be inserted along it as it is withdrawn and then turned, so that its cutting edge is at right angles to the incision and to the shaft of the femur. The femur is then divided for more than two-thirds of its thickness, the chisel being taken in and out of the wound as little as possible. The mallet should have a heavy metal head and a short wooden handle. The cut in the bone must be parallel to the articular surface of the femur, which will be more oblique than natural, owing to the abnormal length of the inner condyle. The anterior and posterior layers of compact tissue must not be neglected, and when dividing the posterior extra caution must be used lest the chisel should be driven into the popliteal vessels. When two-thirds of the bone have been divided the remainder is fractured. If the patient be fully grown, and the bone of some size, two or three chisels may be used successively, the first being the thickest. The operation should be performed with all antiseptic precautions, and an antiseptic dressing applied after it. Macewen has always employed the carbolic spray and the carbolic gauze dressings. If the incision is made in the proper place no vessel requiring ligature is wounded. No sutures should be put into the wound unless it is of unusual size. The dressing may be left unchanged for one or two weeks, unless some discharge shows out from under it, as it may do at the end of the first twenty-four hours. After the operation the limb may be placed on any convenient splint for the first day or two, until it is seen if the dressing requires changing, after which a plaster-of-Paris bandage should be applied. The age at which the operation should be performed has been the subject of much difference of opinion. Experience has shown that if done too early relapse is very likely to take place. As a rule it should not be performed in children under ten. Before that age the deformity can usually be corrected by proper apparatus, aided by forcible straightening not carried to the extent of separation of the epiphysis. The results of the operation have been extremely satisfactory. Up to July 31st, 1884, Macewen had operated on 804 limbs belonging to 409 patients, varying in age from 7 to 46. In 8 cases only did suppuration take place. In 5 cases the operation was followed by death, but in none of these was the fatal result directly due to the osteotomy, one dying of tubercular meningitis, one of phthisis, two of diphtheria, and one of pneumonia, which had commenced before the operation was performed. The average duration of the treatment is about ten weeks, six in splints and four in hospital or at home learning to walk. The patient is usually fully restored to activity in three months from the time of operation.

Genu Varum, Genu Extrorsum or **Bow-knees**, is the reverse of genu valgum. It is almost invariably the result of rickets, and is associated with rickety curves of the tibia and femur. It commences in early childhood, and may then be remedied by properly constructed splints. If not cured at this age osteotomy may be required later on. It may be necessary to divide the tibia well as the femur.

Genu Recurvatum is a rare congenital malformation in which the leg is in a position of over-extension. It is believed to be due to accidental extension instead of flexion of the lower extremities in utero. It is sometimes associated with spina bifida. In some cases the patella has been either imperfectly developed or absent. Great benefit, or even cure, may be effected by the early application of an apparatus gradually bringing the limb into the flexed position.

Contraction of the Knee.—In this condition the knee is fixed in a flexed position. In severe cases the patient cannot put the foot to the ground; hence the limb becomes useless for the purpose of progression. But a leg with a badly contracted knee is worse than useless—it is a positive incumbrance; the limb projects behind in a most awkward manner, swaying as the body moves round, constantly in the way and liable to injury. From want of use, the nutrition of the limb becomes impaired, the foot is cold, the circulation in it is languid, and the toes become liable to chilblains and troublesome ulceration. In the less severe forms of contracted knee, the inconvenience, though not so great as that just described, is very considerable; for, as the patient can never bring the heel or sole to the ground, he rests insecurely on the tips of his toes, and walks but unsteadily with the aid of a crutch or stick.

Varieties.—This deformity may be of two kinds:—1. It may consist of simple flexion of the leg on the thigh, at a greater or less angle, and with more or less mobility, according to the degree of ankylosis. 2. In addition to this, there may be horizontal displacement of the bones, the head of the tibia being thrown backwards, the femur and patella projecting more than is natural.

In examining a case of contraction of the knee-joint, the patient should be placed on his face, with the thigh extended. The leg on the affected side will then be raised more or less perpendicularly, and the amount of contraction may be accurately judged of by the angle that it forms with the thigh. The degree of mobility also may readily be ascertained.

Causes.—Contraction of the knee-joint may arise from a great variety of pathological conditions. Some of these are altogether external to the joint, being seated in the nerves or muscles of the limb; whilst others, and the majority, consist in some morbid change that has taken place within the joint itself in its ligamentous or osseous structures. As the contraction depends on such very varied causes, the treatment, having reference to the cause as well as to the actual morbid conditions, must be equally diversified.

Contraction from Nervous Irritation is usually associated with general hysteria, of which it is but a local symptom, and commonly occurs in girls and young women. In this form of contraction there is no evidence of disease within the joint; no redness, swelling, or other sign of inflammation; but there is great pain and tenderness about it. This pain, as usual in hysterical cases, is superficial and cutaneous. It is not confined to the articulation, but radiates to some distance beyond it. Any attempt at straightening the limb not only greatly increases the pain, but also calls the adjoining muscles into such forcible action that it is impossible to improve the position. These local symptoms are connected with the ordinary signs of a hysterical temperament, with spinal irritation, and often with uterine derangement.

The *Treatment* of these cases of *hysterical contraction* of the knee is simple. The first thing to be done is to straighten the limb. This can be effected only by putting the patient under the influence of an anæsthetic, when, all sensibility being suspended, the muscular opposition, which is partly voluntary, and no doubt in some measure reflex, is no longer called into action, and the limb falls of its own accord almost into the straight position, in which it must be retained by means of a back splint, lest the retraction recur with returning consciousness; and then, the hysterical condition being removed by treatment calculated to improve the general health, the tendency to the return of the deformity will be obviated.

We occasionally see contraction of the knee from spasmodic action of the hamstrings, produced by some irritation applied to the nerves at a distance from the part.

Contraction from Inflammation of the Knee.—In inflammation of the knee, the patient instinctively places the limb in the semiflexed position, as being that in which there is least tension exercised on the structures that enter into the joint. This position, which is immediately assumed on the occurrence of acute and active inflammation in the joint, comes on more gradually in cases of subacute inflammation; and here the symptoms of disease in the joint may be so slight that the contraction may be considered the chief ailment, and engross too exclusively the Surgeon's attention.

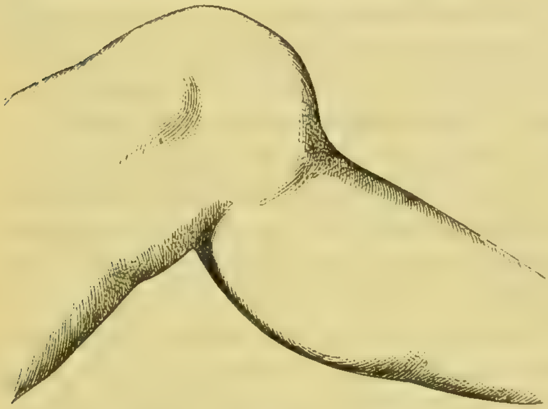


Fig. 644.—Chronic Contraction of Knee-joint; Head of Tibia drawn backwards.

Chronic Contraction.—The next class of cases that we have to consider are those of a more chronic and intractable kind, lasting often for years, dependent upon structural lesions of a deep and important character in and around the joint, and requiring very active surgical interference for their cure. Those chronic forms of contracted knee appear to range themselves in three distinct varieties, being dependent on: 1, Consolidation and Contraction of the Ligamentous Structures in or around the joint; 2, Permanent Contraction of the Muscles, with or without the last-named condition; and, 3, Osseous Ankylosis. Each of these varieties will require separate consideration, as each demands a special mode of treatment for its cure.

1. Those cases of contraction of the knee that depend on *Consolidation of the Ligamentous Structures* in and around the joint, resulting from former inflammatory attacks, are the most numerous, and the most amenable to treatment. When the capsule and ligaments are the parts chiefly affected, the inflammation has usually been of a rheumatic character. When the internal structures have been disorganized, and fibrous bands have formed within the joint, the inflammation has generally been tubercular. In these cases the knee is usually fixed at or near a right angle, and is capable of but very limited motion. The hamstring muscles are not tense, unless the knee is extended to its utmost; and, indeed, in some cases they are flaccid, and feel soft. Not unfrequently the leg can be extended up to a certain point, with as much freedom as in the natural state, and then further movement is checked by a sudden stop. If this be not dependent on the tibia coming into contact with an ankylosed patella, it is owing to shortening of the

ligament of Winslow, or of the anterior crucial ligament, or to the formation of adhesions within the joint. In this form of contraction, the knee is often much distorted, in consequence of the head of the tibia being partially dislocated backwards, the femur having its axis directed more or less on one side, most commonly inwards, constituting a kind of genu valgum. In fact, in these cases the distortion of the limb is of a threefold character; there are, 1, contraction in the angular direction backwards; 2, displacement of the head of the tibia backwards from the lower end of the femur, which projects considerably forwards; and 3, rotation of the leg and foot outwards. The angular contraction is dependent upon adhesions in the joint, and on the gradual tendency to flexion that all inflamed joints assume. The partial dislocation backwards is dependent on softening and consequent relaxation of the posterior crucial ligament, and partly also of the lateral ligaments. When the head of the tibia is displaced backwards, it will sometimes be found that the ligamentum patellæ has been either partially absorbed, and thus weakened; or that it is elongated, the patella being drawn upwards or to one side. In either way, the action of the extensor muscles of the thigh upon the head of the tibia is weakened; and that bone, being consequently brought under the influence of the hamstrings, which also act more advantageously in the flexed position, is drawn backwards (Fig. 644). In those cases in which there is lateral rotation of the tibia, the faulty position arose either from the attitude that limb was allowed to assume during the progress of the disease in the joint, or the leg was rotated outwards by the action of the biceps overcoming that of the inner hamstrings.

When the knee has been chronically contracted for some length of time, the ligamentum posticum becomes permanently shortened from adhesion of the sides of the folds into which it is thrown by relaxation. And a similar shortening takes place also in the anterior crucial ligament when it is relaxed by displacement of the head of the tibia backwards. Hence the condition of these ligaments offers the chief obstacle to extension.

Treatment of Contraction of the Knee.—Extension of the limb will prove sufficient when there is simple angular contraction. This may be done either gradually by means of the screw-splint behind the knee, or forcibly and at once, under the influence of anæsthetics. I prefer the latter method, not only as being the speediest, but as being perfectly safe and effectual. The mode of effecting forcible extension is as follows. The patient being fully under the influence of an anæsthetic, and lying on his face, the Surgeon, standing above him, seizes the foot of the affected limb with one hand, whilst with the other he steadies the limb just above the knee. He now extends the leg gradually but forcibly; as it comes forwards, the bands of adhesion in and around the joint will be felt and heard to give way with loud snaps and cracks, distinctly audible at some distance. Should there be much resistance within the joint, the Surgeon may apply his own knee or elbow to the upper surface, and thus increase the force with which the limb is acted upon. In this way I have never found any contractions of the kind now under consideration able to resist the Surgeon's efforts, nor any difficulty in effecting at once the extension of the limb. Nor have I ever seen any evil consequences result; indeed, it is surprising to what an amount of force a joint that has been contracted for any length of time may be subjected without inconvenience. Beyond some pain for a few days, and slight heat, easily subdued by evaporating lotions, I have never seen any ill results arise ; but care must be taken that no inflammation is going on within the joint at the time of this manipulation, for, if this were present, the operation would certainly be followed by injurious results. After extension has been made, the limb should be fixed on a long splint, well padded, or on a Thomas's knee-splint, some evaporating lotions applied, and the patient kept in bed for a few days, after which, with the aid of a starched bandage, he may walk about.

When the triple displacement which has already been referred to exists—viz., angular contraction, displacement of the head of the tibia backwards, and rotation of the limb outwards—simple extension is no longer sufficient to remedy the deformity. In these cases the hamstring tendons often require division, generally on both sides—sometimes only the external one ; and extension may then be effected, either forcibly, or by the gradual and slow action of rack-and-pinion apparatus. When extension is complete, the backward displacement of the head of the tibia may still occasion considerable deformity and weakness of the limb (Fig. 645). This condition is best removed by the use of the instrument of which the sketch on next page (Fig. 646) is a good representation ; it was designed and constructed by that excellent surgical mechanician, Mr. Bigg. The diagram represents a limb with the tibia displaced backwards, the angular contraction having been remedied. In the centres of the lower end of the thigh-bone and of the head of the tibia, two letters (X and Z) are placed to designate the axis of each bony head, beneath and above which the displaced joint has formed its abnormal axis. The dotted lines represent the leverage formed by the cylindrical surface of the tibia and thigh-bone. The arrows are placed in such a direction as the bones would take in resuming their normal position. It will readily be seen that any instrument capable of acting in the mechanical directions shown by the arrows, would not only accomplish the restoration of the joint, but extend, if contracted, the extremities of both femur and tibia. An additional advantage that this instrument possesses over any other with which I am acquainted, is the application of spring-power, by means of which flexion of the knee becomes an element towards the restoration of its utility. Instead of muscular action being arrested, and atrophy of the limb being thus produced, movement is conducive to the perfect action of the apparatus ; so that the patient experiences but little inconvenience from its use, all the ordinary positions assumed by the knee in walking, sitting, or standing being preserved. By this form of apparatus, then, three important points are secured : viz., replacement of the head of the tibia, extension of the angle of the leg, and free muscular action during the period of treatment.

In Fig. 646, A and B are two levers, composed of metal, corresponding in their direction to the perpendicular position of the thigh-bone and tibia. C and D are two axes, placed exactly coincident with the centres of the articular ends of the bones. E and F are two powerful springs, acting in opposing directions ; viz., in those indicated by the arrows in Fig. 645. Thus F presses the lever B in a forward direction, bearing the end of the tibia forward, whilst E presses the lever A in a backward direction, bearing the end of the thigh-bone backward. As C and D are found acting above and below the actual axis of the knee-joint, they mutually influence the point formed by the apposition of the heads of the tibia and thigh-bone ; and as it has already been explained that the thigh-bone really offers a fixed resistance, and the tibia moves beneath it, the head of the latter bone is brought forward in a semicular direction consequent on the upper centre (C) being a fixed point, and the lower centre (D) rotating around it. G is an elastic knee-cap; H, a padded plate. When the ligaments are tense, there is a chance of pressing the anterior surface of the tibia against the posterior surface of the thigh-bone. This is readily obviated by having the shaft (A) made to elongate, when the centre (C), being a little lowered, pushes the lever (B) downwards, carrying the tibia with it, and thus separating the osseous surfaces of the joint.

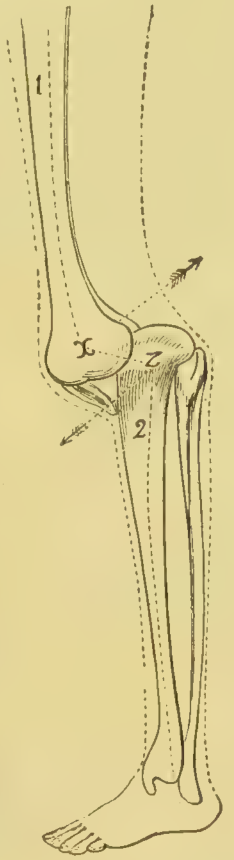


Fig. 645. — Knee-joint after Extension: Head of Tibia thrown Backwards.

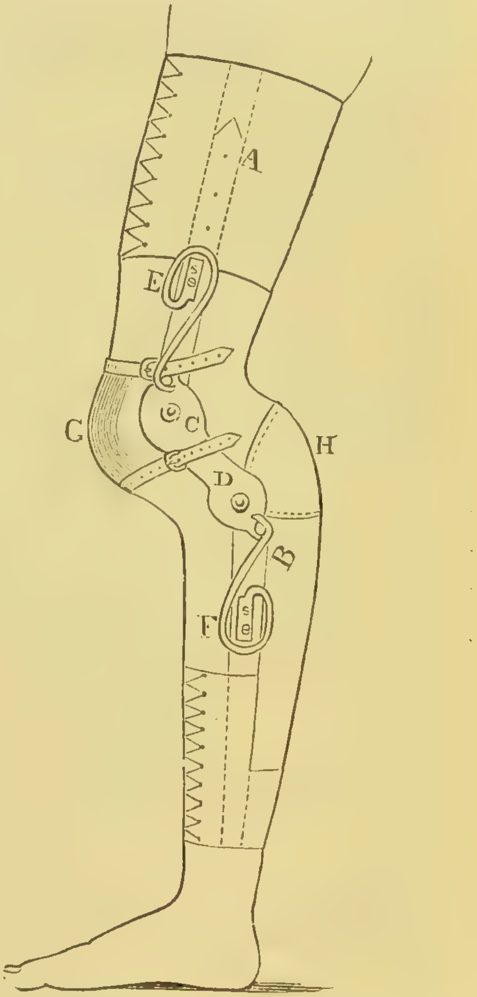


Fig. 646.—Apparatus for restoring Position after Extension of Contracted Knee-joint.

2. The next class of cases of contracted knee that we have to consider is that in which the *Hamstrings are Contracted*, either alone or in addition to those results of chronic inflammation within the joint that have just been described. In these cases the hamstrings will be found to be tight; and, in proportion as the leg is extended on the thigh, they will become more tense, until at last all further extension is resisted, apparently by their traction, and not by any sudden check or stop within the joint itself.

Division of the Hamstring Tendons is in ordinary cases unattended by any difficulty, provided the Surgeon introduce the tenotome close to the side of the tendon to be divided, and cut in a direction from the popliteal aspect towards the skin. The outer hamstring will usually be found to be the most tense, and should first be divided. In doing this, the external popliteal nerve might appear to be in danger; but this may be avoided by keeping the side of the tenotome well against the inner edge of the biceps tendon, then turning the edge outwards, when passed deeply enough. The semitendinosus next requires division. The semimembranosus need not often be cut across. After the division of the tendons, tense aponeurotic bands will not unfrequently be found to stretch along one or both sides, or perhaps down the centre of the popliteal space. This may lead to the idea on the part of the Surgeon that he has not fairly cut the tendons across; but this is an error. The bands alluded to are condensed sharp-edged prolongations of the fascia lata, formed during the period of contraction of the joint by the shrinking and thickening of this membranous expansion. Such condensations as these had better be left untouched, as they will readily stretch out under gradual extension, or be ruptured by forcible traction of the limb. If, on the other hand, the Surgeon be tempted by their apparently superficial and safe position to proceed to their division, he may be brought more closely into contact with the popliteal vessels than is desirable. In these cases, the anatomical relations of parts are so much altered by the narrowing of the popliteal space, and by the projection of the head of the tibia backwards, or by its lateral rotation, that the Surgeon is unable to calculate with sufficient nicety the position of the large vessels and nerves, and he may thus injure one or other of these at a time when he thinks that he is operating at a safe distance from them.

After division of the hamstrings, the knee does not commonly come readily into the straight position, owing to the shortening of the ligament of Winslow and the anterior crucial ligament, and gradual extension, by means of proper apparatus, will be required to overcome this and to stretch the adhesions within and around the joint.

Contraction with Lateral Displacement is not unfrequently met with. In these cases the knee is contracted more or less in the angular direction; but, in addition to this, the lower end of the thigh-bone is directed inwards and perhaps somewhat forwards, and the tibia is rotated outwards, carrying the foot with it. There is thus a triple deformity—angular, mesial, and rotatory. I believe the angular to be the primary deformity, and the mesial and rotatory to be secondary to this, arising partly from the efforts of the patient to walk by resting on the point of the great toe, and throwing the thigh inwards in order to effect this, and partly from the action of the biceps rotating the leg outwards.

The *Treatment* of these cases is not very satisfactory. The obstacle to the restoration of the normal position of the joint is dependent, so far as the angular contraction is concerned, on shortening of the ligamentum posticum, and the rotatory displacement is kept up and rendered intractable by shortening of the anterior crucial ligament. Mere extension of the limb, whether gradual or forced, may counteract the angular deformity; but it will not only leave the other displacements uninfluenced, but may actually increase the displacement of the tibia backwards and the rotation of the leg outwards. A leg-and-thigh splint, such as in Fig. 646, but having, instead of the springs, a rack-and-pinion apparatus working on three centres, so as to extend the limb, abduct the knee, and rotate the leg inwards, is the only contrivance by which this deformity can be counteracted, and the limb restored to shape.

In these various deformities of the extremities it may be stated generally that it is much easier to rectify faulty position than to restore mobility. The first may always be done by the various means that have been enumerated; the latter can be effected only, if at all, by long-continued efforts on the part of the Surgeon, by passive motion, frictions, shampooing, &c., aided by properly constructed apparatus.

In ankylosis of the knee, after extension has been made, and the limb brought straight, the question arises as to whether mobility of the joint should be encouraged, or the limb kept straight and made stiff. The answer to this question will greatly depend on conditions of the muscles of the thigh. If the quadriceps extensor exhibits electric irritability, then, if the state of the joint admit it, motion may be attempted. If the muscles be insensible to the stimulus, then the joint had best be kept stiff.

3. **Osseous Ankylosis of the Knee** is not of very unfrequent occurrence. It is usually the result of traumatic inflammation of the joint. If the limb be straight, no operation will be advisable; if it be *bent*, so that the patient cannot put the foot to the ground, the only remedy will be an operation. Rhea Barton, of Philadelphia, in 1835, proposed an operation for restoring the straight position of the limb in cases of complete osseous ankylosis of the knee-joint with angular deformity. The proceeding consists in excising a wedge-shaped piece of the shaft of the femur above the condyles, not including the whole diameter of the bone, then fracturing the undivided portion, and so bringing the limb into a straight position. Birch, of New York, in 1844, modified this operation by sawing out a wedge-shaped portion, consisting of the condyles of the femur, the patella, and the head of the tibia. In one case, that of Reil, the femoral artery had to be tied for secondary hæmorrhage from the popliteal on the fifteenth day; but the patient made an excellent recovery with a useful limb. Brainard of Chicago, in 1854, proposed a simple and less severe method than either of the above, for the remedying of angular osseous ankylosis of the knee. It consisted in drilling the femur subcutaneously and then fracturing the bone. This operation was first done by Pancoast in 1859, and since then has been successfully practised by Brainard, Gross, and others, who have extended it to subcutaneous perforation of the joint and to separation of the patella.

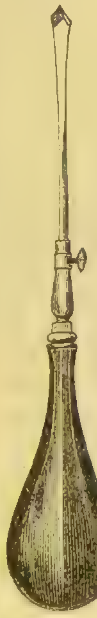


Fig. 647.—Drill for Ankylosed Knee.

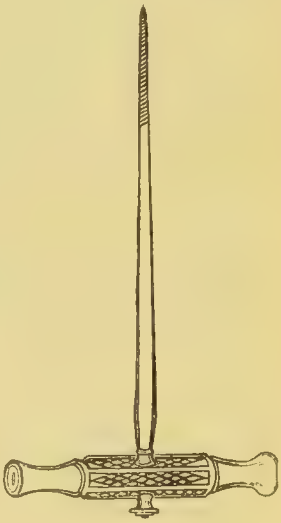


Fig. 648.—Drill for Ankylosed Joint.

The drill used for this operation consists of a steel shaft 4½ inches long, fitted with a solid and rounded handle (Fig. 647). The point is ⅙th of an inch in breadth, and has on each side an oblique groove with cutting edges, so that it acts as a gouge as well as a drill. The interior of the obliterated articulation is reached by making an incision about half an inch long on the outer side of the limb, at the line of junction between the condyles of the femur and the tibia. The drill is then worked through, until its end can be felt under the integuments on the opposite side of the limb. The instrument must now be worked in such a manner as to break down the osseous adhesions between the femur and the tibia on the one hand, and the patella on the other. The patella is sometimes best loosened by using the drill as a lever. When the bones have been sufficiently perforated in different directions, the limb must be extended, when the remaining osseous connections will give way with a cracking noise. The wound in the integument is then closed with silver sutures and collodion, and the limb laid on a pillow. In three or four days it may be put in a McIntyre splint, and gradual extension practised, the soft parts posteriorly slowly yielding. Bony union will then take place; but it is a decided advantage when the limb is stiff for the knee not to be quite straight, but slightly flexed, so that the leg may be about an inch shorter than the opposite limb.

This operation, it will be seen, is in many respects superior to those of Barton and Buck; for whilst bringing the limb into an equally good position it does so by a comparatively slight and subcutaneous procedure, unattended by any danger of hæmorrhage or of complications arising from an extensive open wound. The nine cases in which it has been done were all successful. These various perforating operations appear hitherto to have been confined to the knee-joint. But there can be little doubt that they might advantageously be extended to other joints affected by osseous ankylosis, more particularly in the hip. In angular contraction of the knee-joint with dislocation of the tibia backwards, Volkmann has corrected the deformity, by cutting across the femur just above the condyles, and in one case by doing the same to the tibia just below its head. This he recommends to be done with a chisel, the wound being dressed antiseptically.

Ankylosis of the knee in the straight position interferes comparatively little with the utility of the limb. It is, however, desirable, when practicable, to restore the mobility of the joint. The possibility of doing this will depend on the degree of ankylosis. If this be osseous, or even densely fibrous, little can be done; but if the rigidity depend chiefly on condensation of the capsule, and fibroid induration outside the joint, much may be effected by the use of properly contructed apparatus. This should be of two kinds: 1. A leg-and-thigh piece securely laced on to the limb, having an angular joint opposite the knee, and connected posteriorly by a strong band of vulcanized india-rubber, the elastic tension of which is constantly striving to overcome the straightened limb by flexing it backwards; and 2, a similar apparatus with rack-and-pinion, instead of elastic, by which the knee can be forcibly flexed once at least in the day.

Ankylosis of the knee in the *angular position forwards,* so that the leg is over-extended upon the thigh, is very rare. Indeed, I am acquainted with only three preparations illustrating this deformity—one in the museum of University College, one in that of St. Thomas's Hospital, and another exhibited by Adams to the Pathological Society, from a limb amputated by Grant of Canada, in which this condition occurred to a young man as a consequence of a wound of the joint some years previously.

Deformities of the Bones of the Lower Limb from Rickets.—The distortions of the bones of the leg arising from rickets have already been alluded to in the chapter on diseases of bone. It is needless here to do more than mention that antiseptic osteotomy has been applied of late years with great success to the treatment of these deformities. It is seldom that any operation beyond that already described for knock-knee is required in the femur. In the tibia the curve is most commonly outwards and forwards, often to such an extent as seriously to cripple the patient. In these cases a wedge-shaped piece of bone is often removed from the most prominent part of the curve, but as good a result can usually be obtained by simple division of the bone by the chisel and mallet, used in the same way as in the operation for knock-knee. If necessary, the same bone may be divided in more than one place, either simultaneously, or the second operation may be deferred till the patient has recovered from the first. In complicated cases of knock-knee with rickety curves of the femur and tibia, Macewen has performed as many as ten osteotomies simultaneously on the same patient. If proper antiseptic precautions are adopted, the danger of these operations is very slight, as may be seen from the result of Macewen's practice (p. 530).

CLUB-FOOT.—The deformities classed together under the name of club-foot or talipes may be either congenital or acquired.

Causes.—The *acquired* forms may be developed at any age, but are most commonly met with in young children, as the result of paralysis of certain muscles or groups of muscles, the foot then being drawn out of position by the uncontrolled action of their opponents. In later life displacement may be the result of the gradual shortening or " contracture " of the muscles that is not uncommonly met with in hemiplegia. These causes are central, but similar deformities frequently result from wounds or other injuries of the nerves supplying the muscles, or from diseases or injuries of the muscles themselves, accompanied by loss of substance and consequent shortening.

The *congenital* forms of club-foot have also been ascribed to central causes giving rise to spasm or paralysis of certain groups of muscles, and this explanation is doubtless correct in some cases, especially in those in which the deformity is accompanied by spina bifida. That it is true of all, however, seems highly improbable. Not only is there no evidence at birth in the majority of cases, either of spasm or paralysis, but, as has lately been shown by R. W. Parker and S. G. Shattock, a most careful microscopic examination of the nervous centres, the nerves, and the muscles, fails to show any structural abnormality. The occurrence of the deformity seems in most cases to be best explained by the theory that it is due to mechanical causes, such as malposition in utero, the pressure of the uterus, &c.

Talipes may affect one or both feet, and may occur in either sex, but appears to be more common in boys than girls. There are four primary varieties of club-foot, and two secondary ones. Of the four *primary* forms, in two the deformity is in the antero-posterior direction, in the sense of flexion and of extension : **Talipes Equinus,** in which the heel is drawn up and the toes pointed downwards ; and its antithesis, **Talipes Calcaneus,** in which the heel is pointed downwards and the foot and toes drawn up. In the remaining two forms the deformity is lateral, the foot being adducted and twisted inwards in **Talipes Varus,** and abducted and twisted outwards in **Talipes Valgus.** The four primary forms of club-foot correspond with and are dependent on a permanent condition of one or other of the four simple movements of which the foot is susceptible at the ankle-joint. Thus in Talipes Equinus the foot is extended, the heel being raised, and the dorsum pointing downwards in a line more or less direct with that of the anterior part of the leg. This is associated with shortening of those muscles that are inserted into the os calcis through the medium of the tendo Achillis. In Talipes Calcaneus the foot is drawn up and the heel depressed, so that the dorsum forms an angle more or less acute with the front of the leg. Here the tibialis anticus is the muscle chiefly at fault. In Talipes Varus the foot is adducted forcibly, and the inner side of the sole raised sometimes to a right angle with the ground; this may be due to the unopposed action of the tibialis posticus and tibialis anticus; and in Talipes Valgus we have the converse—abduction of the foot, and raising of the outer side of the sole, due to a similar condition of the peronei.

Besides these four primary forms, there are two secondary varieties of club-foot; **Talipes Equino-varus,** in which the heel is raised and the foot drawn inwards; and **Talipes Calcaneo-valgus,** in which the heel is drawn down and the foot turned out. The association of Talipes Equinus and Varus has been explained by supposing that it is due to contraction of the muscles supplied by the internal popliteal nerve, especially the gastrocnemius and soleus and the tibialis posticus, and in the same way Talipes Valgus and Calcaneus are associated, because in these the extensor and peroneal muscles supplied from the external popliteal are the seat of contraction. That this is the case in certain acquired cases is undoubted, but there is no evidence that these nerves are in any way affected in cases of congenital club-foot.

In acquired cases, the result of infantile paralysis, the muscles opposed to those that are shortened may be found to be paralysed and possibly atrophied. In such instances, if the patient is seen sufficiently early, electricity may be of service.

Pathological Changes.—On dissecting a foot affected by talipes, it will be found that scarcely any alteration has taken place in the bones. In some preparations of this kind which are in the University College Museum, they are nearly normal (Figs. 650 and 653). Indeed in Talipes Equinus and Calcaneus they are scarcely if at all altered; but in varus a slightly increased obliquity of the neck of the astragalus is almost constantly present. If the varus be of old standing, the astragalus will generally be found to be atrophied, more particularly about its head, and the navicular and cuboid bones may have suffered similar changes. The ligaments are necessarily altered in shape in all forms of club-foot, being shortened or lengthened, as the case may be, to adapt them to the altered position of the bones. It has recently been pointed out by Parker and Shattock that the ligaments take a far more important part than is generally recognized in maintaining the abnormal position of the foot. Thus they showed that in cases of congenital talipes varus the whole of the soft parts except the ligaments may be dissected away without materially diminishing the deformity of the foot. The direction of the tendons is altered, and the muscles, not only of the foot, but of the leg, and sometimes even of the thigh, are generally atrophied from disuse, so that the limb in old cases is withered and shortened. In many instances the deformity becomes aggravated when the patient walks upon the diseased foot.

Talipes Equinus is characterized by elevation of the heel, and tension of the tendo Achillis. In slight cases the heel may merely be raised a few lines above the ground, and it will be found on examination that it cannot be bent forwards to an acute or even to a right angle with the leg. In severe cases the foot may be extended in nearly a straight line with the leg, and the

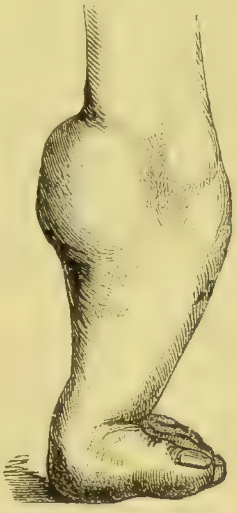


Fig. 649.—Talipes Equinus.

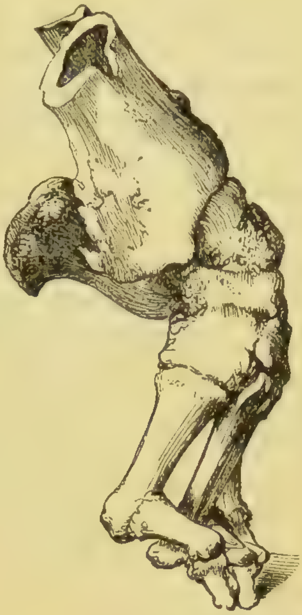


Fig. 650.—Bones in Talipes Equinus.

patient walks on his toes, which are placed at a right angle to the foot (Figs. 649, 650). In this deformity there is no lateral displacement. According to Tamplin, it is never congenital. It most commonly arises from disturbance of the nervous system during teething. In adults, as well as in children, it may come on from some disease, such as an abscess in the calf of the leg, by which the gastrocnemius muscle is crippled, shortened, and contracted. It is in itself the simplest of all the forms of club-foot; it commonly complicates T. varus.

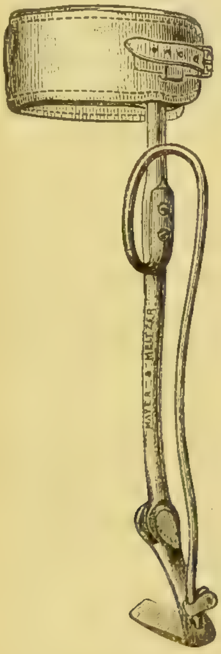


Fig. 651.—Apparatus for use after division of tendo Achillis for paralytic equinus.

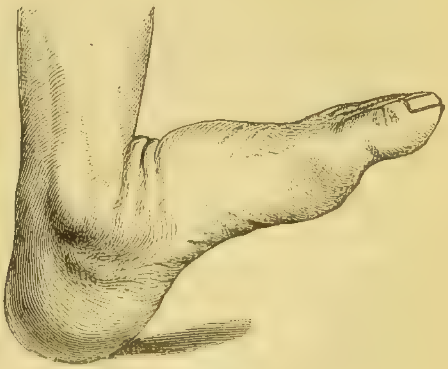


Fig. 652.—Talipes Calcaneus.

The *Treatment* consists in *dividing the tendo Achillis*, and afterwards flexing the ankle by a proper apparatus. The tendo Achillis is best divided about an inch above its insertion into the os calcis. The limb should be placed on its outer side. The assistant then relaxes the tendon slightly while the Surgeon slides a tenotome beneath it from the inner side; the assistant then makes the tendon tense, and the Surgeon proceeds to divide it, using the knife as a lever, the fulcrum being the edge of the malleolus. The Surgeon must keep the fingers of his left hand on the tendon to feel that the knife does not approach the skin too closely. As the section proceeds, he will hear the tendon creaking as its fibres are successively cut through. The division may be safely made from the cutaneous surface if it be preferred. The tendon must be made tense, and the point of the tenotome entered through the skin close to its anterior surface; the foot is then fully extended, while the Surgeon pinches up the skin, and passes the tenotome between it and the tendon. He then turns the edge of the knife to the tendon, while the assistant forcibly flexes the ankle. No sawing or free cutting is required if the knife have been entered sufficiently far forwards. With ordinary care, there is no risk of wounding the posterior tibial artery.

In cases in which the deformity is due to paralysis of the tibialis anticus and extensors of the toes, a condition very frequently met with as the result of infantile paralysis, the apparatus represented in Fig. 651 fitted to a boot, will be found of great use in preventing the return of the contraction after division of the tendon.

Talipes Calcaneus is a rare variety of club-foot. In it the heel is depressed, the toes and anterior part of the foot being elevated (Fig. 652); it is usually, I believe, congenital—in one case under my care, however, that of a girl twelve years of age, it was acquired, arising from contraction of the extensors consequent upon loss of power in the flexors. It is sometimes met with in cases of spina bifida.

Treatment.—In order to bring down the foot, the tibialis anticus, the extensor communis, the extensor pollicis, and the peroneus tertius tendons, may all require to be divided as they pass over the dorsum; a straight splint should then be applied, and the foot drawn down to it. A minor degree of this affection consists in a peculiar projection upwards of one or two of the toes, associated with some tension of the extensor tendons; by dividing this, and keeping the foot on a flat splint, the deformity may commonly be corrected. In some cases, however, the toe is so prominent, and the contiguous ones are squeezed under it in such a manner, that the foot is completely crippled, and amputation of the displaced digit is required in order to restore the utility of the member.

Talipes Varus.—In this deformity the foot is twisted inwards, the inner side of the sole is raised, and the concavity of the arch of the foot is greatly increased. The patient walks upon the outer side of the foot, where the skin covering the tarsal end of the fifth metatarsal bone and the cuboid usually becomes excessively dense and firm, and a bursa forms beneath it (Fig. 654). Congenital talipes varus is almost invariably associated with equinus. The ankle-joint is commonly in a position of extreme extension. The astragalus and os calcis maintain their normal relations to each other, and are more or less adducted. The chief displacement is at the transverse tarsal articulation between the os calcis and cuboid, and the astragalus and scaphoid. The anterior part of the foot is in a position of extreme flexion, adduction, and rotation inwards, amounting in many cases to partial dislocation. A great part of the head of the astragalus which should be normally in contact with the scaphoid is thus uncovered, and forms a prominence beneath the skin. In old cases the cartilage of the head will be found to have disappeared, its place being taken by a layer of dense fibrous tissue. The bones in front of the transverse articulation maintain their normal relation to each other. The muscles that are shortened in this position of the foot are chiefly the tibialis posticus, tibialis anticus, and the muscles of the calf inserted into the tendo Achillis. But as before stated, all these may be dissected away, even in the limb of a new-born infant, without materially diminishing the deformity. The deformity is maintained, as has been pointed out by R. W. Parker, chiefly by shortness of the ligaments which have become adapted to the abnormal position of the bones. "The ligaments chiefly at fault are those placed on the inner border of the deformed foot, namely, the anterior portion of the internal lateral ligament of the ankle, the astragalo-scaphoid and the calcaneo-scaphoid ligaments, all three being blended together into one indistinguishable capsule of great strength." In more severe cases which have been walked upon, the long and short plantar are shortened, as is also the plantar fascia, and in extreme cases the skin of the sole may be insufficient to allow of full extension of the contracted arch of the foot.

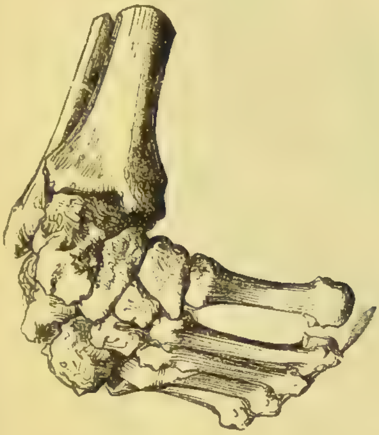


Fig. 653.—Bones in Talipes Varus.

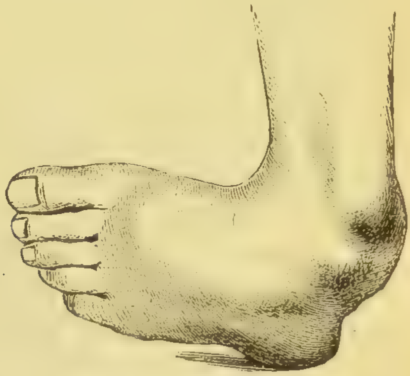


Fig. 654.—Talipes Varus.

Talipes equino-varus is by far the most common form of congenital club-foot, but is occasionally acquired as the result of infantile paralysis of the peronei and extensors. It is very commonly double when congenital.

The *treatment* consists in the application of some efficient extending apparatus aided, if necessary, by division of the muscles, ligaments, or fasciæ which maintain the deformity.

In infants with talipes, Sayre begins treatment at once, as soon as possible after birth, by drawing the foot into position. When this is done, it becomes quite white and bloodless. The traction must then be discontinued, but may be resumed again in a very short time, and so repeated. After a time the limb may be fixed in proper position by the application and traction of plasters ; and thus if the talipes be not cured, it may very early in life be much ameliorated and rendered more fit for operative treatment.

If in attempting to pull the foot into position, the tendons of the two tibiales become very tense, they may be divided. After these have been cut across, the tendo Achillis should be divided ; but it is better in all cases to delay this for some weeks, as it steadies the foot and thus facilitates the correction of the lateral displacement. The plantar fascia requires division wherever it feels tense and projecting. In the section of the tibialis posticus tendon behind the ankle, there is much danger of wounding the posterior tibial artery, which lies close to it.

The best way to avoid this vessel is, as Tamplin recommends, to puncture the sheath with a sharp tenotome introduced close to the tibia, immediately above the malleolus. In adults or young children past the age of infancy, a small point of bone can be felt in this situation, which marks the upper limit of the groove in the malleolus in which the tendon lies. The puncture should be made above this, otherwise the knife cannot be passed under the tendon. After the sheath has thus been opened by a puncture, a blunt tenotome is introduced, care being taken not to use so much force as to push it through the sheath on the opposite side. The tendon is then divided in the usual way. If the operation be performed too high up the limb, the flexor longus digitorum will be divided with the tendon of the tibialis posticus, but this is a matter of little moment. Unless care be taken in cutting through the tendo Achillis, there is also some risk of wounding the artery ; as, in bad cases of varus, these two structures lie close together, the tendo Achillis being drawn out of the median line towards the inner ankle. Indeed, in one

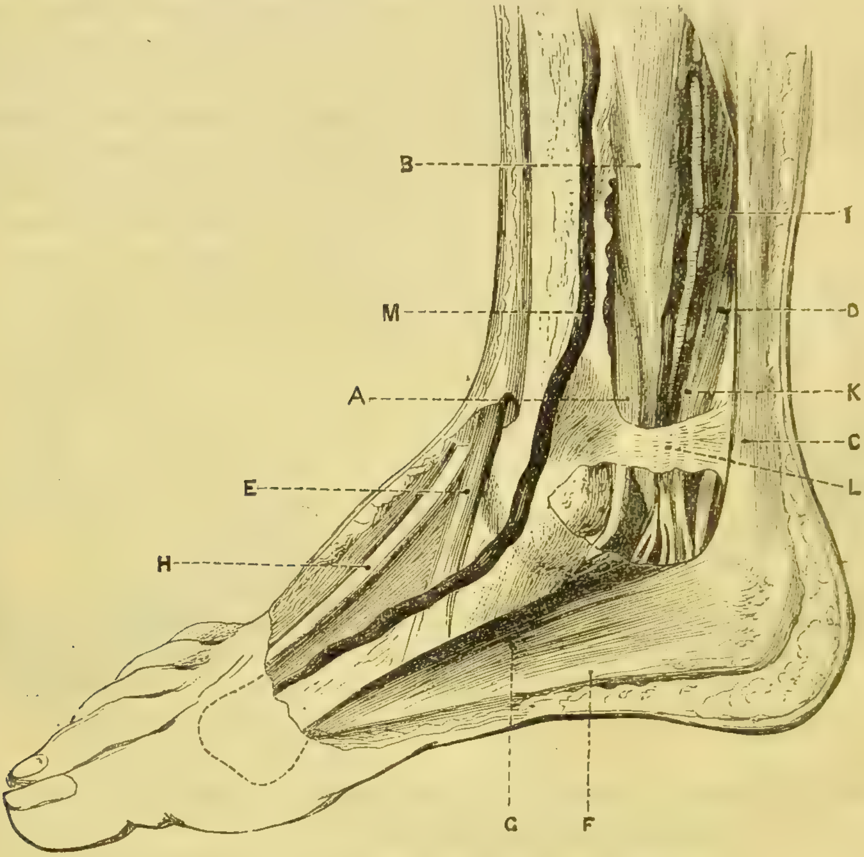


Fig. 655.—Relation of Tendons divided in Equino-Varus.

A Tibialis Posticus. Point at which cut.
B Flexor Longus Digitorum.
C Tendo Achillis. Point at which cut.
D Flexor Longus Pollicis.
E Tibialis Anticus. Point at which cut.
F Plantar Fascia.
G Abductor Pollicis.
H Extensor Longus Pollicis.
I Posterior Tibial Artery.
K Posterior Tibial Nerve.
L Part of Annular Ligament.
M Saphena Vein.

instance I have seen the posterior tibial artery punctured during the division of this tendon, or rather in an attempt to divide some tense bands that lay beneath it; the bleeding, which was very free and in a full jet, was however readily stopped by pressure, no bad consequences resulting. The proper plan of treatment, when such an accident occurs, is, when the artery is merely punctured, to cut it completely across, and then to apply firm pressure, by means of a pad and bandage over the bleeding orifice. Tamplin states that he has seen no ill effects follow this accident. If a circumscribed false aneurism form, it must be laid open, the clots turned out, and the vessel tied. No extension of the foot should be practised for some time in such cases, lest the coagulum be disturbed.

The tibialis anticus must be divided at the point marked in Fig. 655. The tenotome must be passed from the outer side to avoid any risk of wounding the dorsal artery of the foot.

In cases in which from the great sense of resistance in attempting to straighten the foot, it is evident that the shortness of the ligaments is maintaining the deformity, R. W. Parker recommends their subcutaneous division by the following method. A curved tenotome with a short cutting blade "should be entered immediately in front of the anterior border of the internal malleolus, the blade as far as possible being kept between the ligaments to be divided and the superjacent skin. The blade is then turned against the surface of the ligament, and, by means of a gentle sawing action, is made to divide it. As the superficial fibres are divided, deeper ones come into play, and must in their turn be divided until bone is reached. By keeping the knife close to the bones and directing its point towards the plantar aspect, the calcaneo-scaphoid ligament can easily be divided. In this operation the tendon of the tibialis posticus will almost certainly be divided, and not improbably that also of the tibialis anticus. The long and short plantar ligaments can most effectually be reached just where they pass between the two bones. A straight tenotome must be entered as nearly as possible over the calcaneo-cuboid articulation on the outer edge of the foot. If there be much inversion this point will appear to be on the sole of the foot. The blade must be kept close to the bone and made to follow the direction of the articulation. In this manner, the two ligaments, mostly blended together at this point, will be divided simultaneously." This mode of treatment, founded as it is on accurate pathological investigation, is doubtless a great advance in the treatment of talipes varus.

After division either of the tendons or ligaments, after a lapse of four or five days, Scarpa's or Little's shoe, or Aveling's "talivert" (Fig. 656), a most ingenious and useful instrument, allowing every movement necessary in club-foot, may be applied; or the foot may be well abducted by means of a wooden splint, fixed to the outer side of the leg, and provided with pegs, so placed that the toes can be drawn up, and the foot well turned out, by rollers and tapes attached to them.

In some cases the foot may advantageously be put up in plaster of Paris. In order to do this, it is first bandaged with a narrow flannel roller. The assistant then grasps the leg firmly above the ankle, while he holds the foot in as nearly as possible the normal position by a narrow loop of bandage passed round the ball of the great toe, and held to the outer side. The plaster is then applied, and the foot held in position till it has set. The bandage should be changed about every two weeks, the foot being each time drawn a little more into its proper position.

In spite of all treatment, however, a considerable proportion of cases of congenital talipes equino-varus are at most only partially relieved. In such cases, as the child grows up the muscles fail to develop, and the bones become altered in form so as to adapt them to their abnormal position. In such extreme cases, various operations have been recommended to enable the patient to bring the sole of his foot to the ground. Many years ago Little suggested the removal of the cuboid in order to assist in overcoming the adduction of the anterior part of the foot. This operation was performed with success by Solly in 1857, but did not come into general use. In 1872, Lund of Manchester removed the astragalus from each foot of a child, with the result of obtaining considerable improvement in the position of the feet.

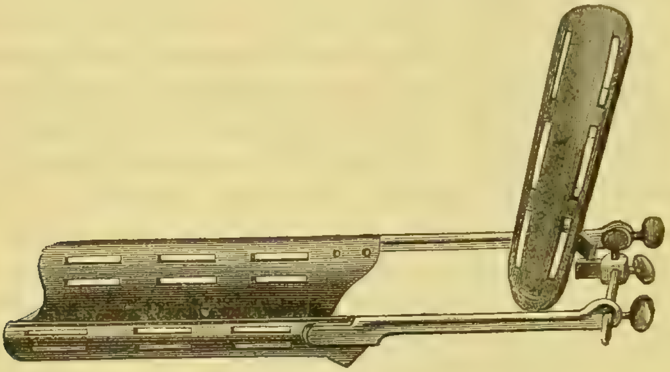


Fig. 656.—Aveling's Talivert.

In 1876, R. Davy repeated the operation in several cases, obtaining good results, but was not able to dispense with prolonged use of apparatus afterwards. In 1876 Davies-Colley recorded a case in which he removed a wedge-shaped piece of the tarsus of sufficient size to allow of the anterior part of the foot being brought into a straight line with the posterior. The operation was performed by a long incision on the outer side of the foot from the middle of the os calcis to the middle of the fifth metatarsal bone. From the middle of this another was carried across part of the dorsum. The cuboid was first excised, after which a wedge-shaped portion of the tarsus was removed "without paying any regard to its articulations." The bones taken away included the whole cuboid, parts of the os calcis, of the three cuneiform bones, nearly all the scaphoid, and a part of the astragalus. R. Davy commences by removing an oblong piece of skin from the outer side of the foot including the false bursa. He then makes a vertical incision on the inner side of the foot in the deep crease that is always present, and of sufficient length to include the thickness of the scaphoid bone. The soft parts are then raised from the dorsum and a "kite-shaped" director specially designed for this purpose is passed between them and the bones. The tarsus is then divided by means of a probe-pointed saw which is guided at first by two grooves in the under surface of the director. It is most convenient to divide the distal side first. The soft parts are then cleaned from the under surface of the wedge of bone by means of a blunt knife or elevator, and the wedge removed in one piece. If the heel is much drawn up, the tendo Achillis can be divided after the operation. Davies-Colley found the most convenient apparatus during the early part of the after-treatment, to be "a back-splint extending from the middle of the thigh to within four inches of the heel. To the distal end of this was fastened a transverse bar of wood, terminating on either side in short upright bars, to which the fore part of the foot was attached by means of strapping." R. Davy uses a splint made of two iron rods fixed to the lower part of the thigh and upper part of the leg by a plaster of Paris bandage. The lower end of each rod is cut into a screw. A foot-piece fixed on a transverse iron bar with a ring at each end slides over the two rods and is fixed by a washer and thumb-piece on each side. The foot-piece is fixed by a pivot and screw to the transverse bar and can be rotated so as to evert the anterior part of the foot. The results of these operations have been very satisfactory. In Davies-Colley's case the patient could jump and hop six months after the operation. Davy has performed the operation in twenty cases with only one death. It is evident, however, that such an operation can only be justifiable when all other means have failed, and can very rarely be required in young children.

H. P. Symonds instead of removing any bone merely divides the tarsus transversely at the level of the transverse articulation by means of a chain saw passed close to the bones. In this way he has obtained excellent results.

Talipes Valgus (Fig. 657) is the antithesis to varus. It is not so frequent a deformity as the other varieties of club-foot. It commonly affects only one extremity, and is occasionally congenital. True valgus arises sometimes from contraction of the peronei, but more commonly from paralysis of their opponents. The foot is everted, the arch is obliterated, so that the sole becomes flattened. The anterior part of the foot is displaced outwards at the calcaneo-cuboid and astragalo-scaphoid articulation, and the scaphoid is partially dislocated outwards, so that the head of the astragalus projects at the inner side of the foot. The toes and anterior part of the foot are often raised so as to constitute the variety termed *Calcaneo-valgus*. The most marked forms of this variety are met with when the muscles of the calf, the tibialis posticus, and the flexors of the toes are paralysed. The projection of the heel backwards is obliterated, and the outer side of the foot curved round so that the little toe is approximated to the point of the heel.

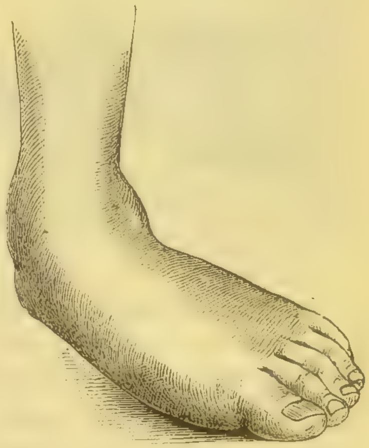


Fig. 657.—Talipes Valgus.

In extreme cases of calcaneo-valgus, the arch of the foot is sometimes increased, the heel being pointed down, and the foot sharply bent at the transverse medio-tarsal articulation, so as to bring the toes to the ground.

Treatment.—In the earlier stages of acquired talipes valgus, the deformity may often be remedied by putting the patient under the influence of an anæsthetic, forcibly drawing the foot inwards so as to overcome the tension of the peronei muscles, fixing it in a Dupuytren's splint, and afterwards restoring the arch of the foot by a convex sole in the shoe.

In the more confirmed cases, the treatment consists in the division of the tendons of the peroneus longus and brevis, behind the outer ankle; and of that of the extensor communis on the dorsum. Scarpa's shoe may then be applied, and the arch of the foot restored by wearing a pad under the sole for some considerable time.

Flat or Splay Foot. Spurious Talipes Valgus is a condition frequently met with in young adults. It is predisposed to by those constitutional conditions that have already been described as favouring the development of curvature of the spine, but the determining cause is most frequently over-fatigue of the foot from long-continued standing, and from carrying heavy weights, or from a slovenly habit of walking by sliding rather than raising the feet, or twisting the foot so as to press upon the inner side. Girls of a tender age being allowed to carry infants, boys set to heavy work beyond their strength, shop-boys and girls mercilessly kept upon their feet for too many hours, will early develop this deformity. When both feet are affected, there is usually knock-knee as well. The disease is due to a weakness of the muscles in the sole of the foot, and to relaxation of the ligaments by which the arch is maintained, especially the ligamentum longum plantæ, and the inferior calcaneo-navicular ligament. As the result of this, the arch of the instep gradually sinks, so that the sole becomes perfectly flat. As the disease advances, a tendency to eversion of the foot takes place. At the same time, owing to flattening out of the arch, the inner side of the foot becomes lengthened, while the outer side, which is naturally but slightly arched, is but little altered. In consequence of this, the anterior part of the foot in front of the medio-tarsal articulation is displaced outwards. The scaphoid is thus partly dislocated from the head of the astragalus, which projects at the inner side of the foot, and being pressed upon, is often a source of much pain. The transverse ligamentous structures that bind together the bases of the metatarsal bones at their digital ends, become weakened and stretched. The consequence of this is, that the gait loses its elasticity, becomes shuffling, and the foot easily tires in walking.

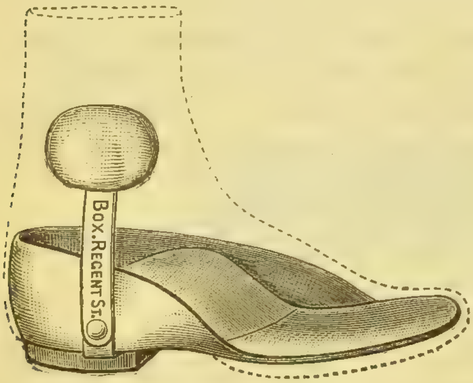


Fig. 658.—Little's boot for Flat foot—right side.

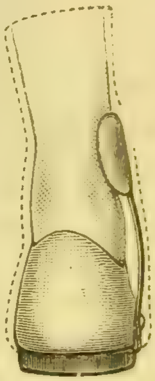


Fig. 659.—Little's boot for Splay foot—right side, seen from behind.

The *Treatment* consists, in the first place, in improving the general health and removing the causes of over-fatigue or strain of the foot, without which surgical treatment may be of little avail. In very mild cases, careful attention to the boots may suffice to give relief. They must be wide at the toe, the heel must be large, and not too high, and made to extend on the inner side to a point opposite the middle of the foot. The boot must be fitted with a "valgus pad," that is to say, a soft pad of cork, or better of india-rubber, placed inside the boot on the inner side in such a position as to support the natural arch of the foot. It is very important that the pad should not be too stiff or too large. The upper-leathers must be strong, reach well above the ankle, and be firmly laced. If the feet are habitually cold, they must be rubbed twice a day with salt and water and warmly clothed. In more severe cases the apparatus represented in Figs. 658 and 659, known as Little's boot, will be found most effectual. It consists of an inner sole to the boot, fitted with a valgus pad. On the outer side is a steel spring fixed to a plate, which extends in the sole from the heel nearly to the middle of the instep. The upper end of the spring takes its bearing from a curved pad which rests against the leg about three inches above the ankle. In the lower part of the spring is a hinge to allow of the free movement of the ankle-joint. The whole is included in the boot, and, beyond making the ankle look a little clumsy, hardly shows externally. The tendency of the apparatus is constantly to push the foot a little inwards, while at the same time it interferes with no movement of the joint, and gives every muscle free play. As the foot improves under its influence, any tendency to knock-knee which may have existed will also diminish, if not disappear When wearing this apparatus the patient, if a child, may be allowed to run and play without restriction. It very rarely fails either to cure or greatly relieve the condition. In very exceptional cases it may possibly be necessary to apply an iron similar to that represented in Fig. 651, but without the spring for flexing the ankle; but this should never be done if it can possibly be avoided. A rigid apparatus of that kind prevents the action of the tibiales and peronei, and thus leads to further weakening of the limb. Various operations have been suggested and performed for bad splay-foot, such as removal of the head of the astragalus, but they have not been attended with sufficient success to encourage their repetition.

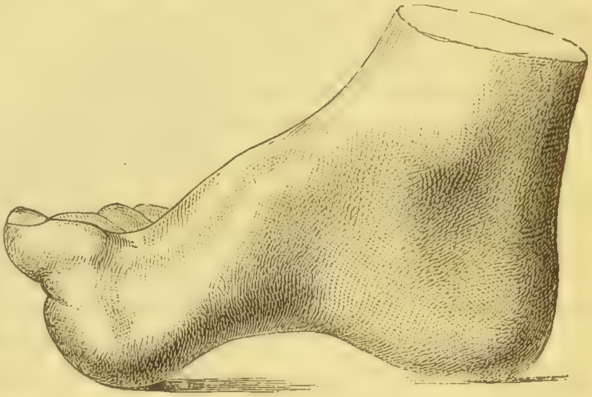


Fig. 660.—Hollow Claw-Foot, pes cavus.

Hollow Club-foot.—As in the hand, so in the foot, the interossei muscles not only move the toes laterally, but powerfully flex the first phalanges, at the same time that they extend the two last. In paralysis of these muscles, and of the short flexor and adductor of the great toe, the toes assume the constrained position of a claw, *i.e.*, the first phalanges are extended upon the metatarsal bones, and the last two phalanges flexed upon the first. This gives rise to a variety of club-foot which Duchenne calls "hollow claw-foot." This is often complicated by paralysis or atrophy of some of the muscles of the leg, giving rise to various associated forms of club-foot.

The accompanying drawing (Fig. 660) shows, 1st, that the first phalanges are extended almost to the point of being subluxated upon the head of the metacarpal bone, whilst the last phalanges are flexed upon the first and form thus a claw: 2nd, that the curve of the plantar arch is considerably increased. According to Duchenne the origin of this hollow claw-foot or pes cavus is as follows.

"When the interosseous muscles are paralysed or atrophied, the tonic contraction of the muscles which extend the first phalanges and that of the muscles which flex the last phalanges being no longer opposed, the claw-like condition of the toes gradually becomes augmented. The posterior extremities of the first phalanges are subluxated upon the heads of the metatarsal bones; then the curve of the plantar arch becomes increased and the plantar fascia shortened; then certain articulations and their ligaments become deformed, as in all club-feet." The mechanism is exactly the same as that of the similar disease in the hand.

This disease makes standing and walking very painful when too prolonged; for this reason, that from the position of the toes and from the increased arch of the foot, the whole pressure in walking is borne upon the heel and upon the skin covering the unnaturally prominent heads of the metatarsal bones, which latter become tender in consequence, especially that over the great toe.

In the case from which the drawing was made, the disease was congenital, but did not trouble the patient till he was ten years old. When he was apprenticed, a long walk always gave him pain, and at last he was obliged to lie up about one week in every month to get rid of his pains. Both feet were affected, but the left much less than the right. By galvanic examination, irritability was found to be entirely lost in the right interossei and very much diminished in the left.

The disease is always accompanied by a tendency to talipes equino-varus, "that is to say, the flexion of the foot upon the leg during walking is incomplete, and during this flexion of the foot the tibialis anticus (flexor adductor) has a predominance of action over the extensor longus digitorum (flexor and abductor of the foot); or in other words, during flexion, the sole of the foot is turned slightly inwards and the dorsum outwards." This is accounted for by considering the unfavourable conditions in which the long extensor of the toes is placed after paralysis of the interossei. The inferior attachment of this muscle is upon a movable point, the posterior and superior extremities of the second and ungual phalanges. The tendency to extension is counteracted by the interossei, which serve to give a fixed point for the extensor longus digitorum to act from, when flexing the foot at the ankle. But when these muscles are paralysed, the attachment of the extensor communis digitorum becomes very movable, and we then see at the moment of flexion of the foot upon the leg, that the first phalanges are drawn back even more than before upon the metatarsal bones, at the same time depressing the heads of these bones. The action of the long extensor as a flexor and abductor of the foot is thus much weakened, and this leads to a predominance in the action of the tibialis anticus (flexor and adductor of the foot), in consequence of which a mild form of varus is produced accompanied by some raising of the heel, due to imperfect flexion of the ankle-joint.

To sum up: this variety of hollow foot (pied creux) is produced by an exaggerated and continued action of the extensors of the first phalanges of the toes—extensor communis digitorum and extensor proprius pollicis, following on a weakness or feebleness of their antagonists—the interossei, adductor, and short flexor of the great toe. Consequently any excess of action of these same extensor muscles, whatever may be its cause, ought to produce exactly identical results.

The knowledge of this fact explains the origin of the hollowed claw-foot that we see produced in talipes equinus, when the long extensor of the toes has preserved its voluntary contractility; and it will be as well here shortly to consider the cause of the alteration in the foot in talipes equinus. As soon as the talipes commences to oppose the flexion of the foot upon the leg, the opposing muscles act with increased vigour to prevent the deformity. This leads to an abnormal extension of the first phalanges of the toes (to which the extensor longus and extensor pollicis are attached), and ultimately to a subluxation of these phalanges upon the dorsal surfaces of the heads of the metatarsal bones. Every attempt at flexion then depresses the heads of the metatarsal bones into the sole of the foot, so increasing the plantar arch. This is most marked in the great toe. The tonic force of the antagonists to the extensors is unable to withstand the exaggerated action of the long extensors.

That the mechanism here given is correct, may be shown by the following fact. In a well marked case of a patient affected with a "hollow claw-footed equinus" (griffe pied creux équin), we should see that any attempt to flex the foot at the ankle leads only to further extension of the toes, which become drawn back over the heads of the metatarsal bones, pressing them down and increasing the arch of the foot. Hence, so far from any raising of the extremity of the foot taking place, it is rather depressed.

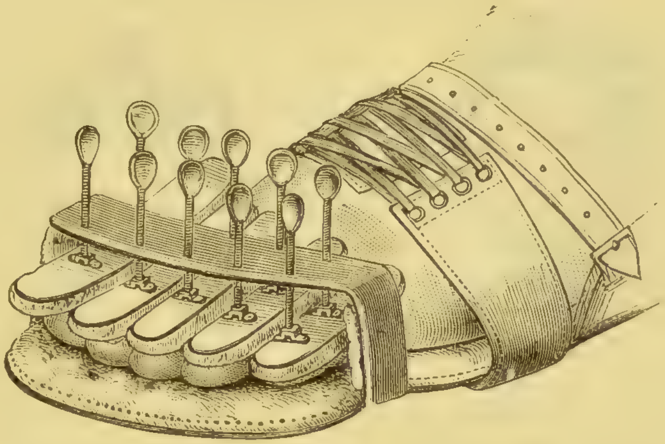
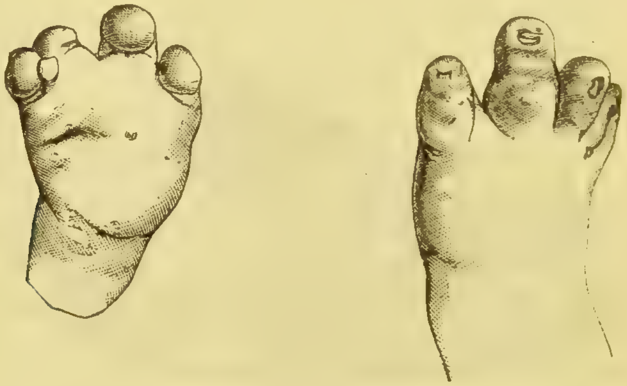


Fig. 661.—Apparatus for obtaining Extension of Toes without Division of Tendons.

The *Treatment* of this condition must be conducted on two principles: 1. The stimulation of the paralysed interossei, adductor, and short flexor of the toe by means of faradization; and 2. The division of the tendons of those muscles which by their tonic contraction maintain and increase the deformity. Those which I have usually found it necessary to divide are the extensor of the great toe, the tendo Achillis, and in addition to these a very tight band of the inner division of the plantar fascia. The Scarpa's shoe that is used after the operation should have hinges across the middle and be provided with a rack-and-pinion movement, so that the depressed heads of the metatarsal bones may be raised by the anterior half of the sole. In some of the slighter cases the instrument here represented (Fig. 661) may be used to obtain the extended position of the toes without division of the tendons.

Contraction of One Toe or Hammer Toe, is not of unfrequent occurrence. In this condition the proximal phalanx is on its normal level or raised up and over-extended; the second phalanx is flexed at an acute angle and cannot be extended, and the third phalanx may be in a line with the second, but is more commonly over-extended. There is always a painful corn over the flexed joint which seriously cripples the patient. The cause of hammer toe is very obscure. It commences almost invariably in youth or childhood, and is occasionally congenital. The deformity is, in some cases, hereditary. It may be aggravated by badly made boots, but does not seem to be primarily caused by them. The second toe is most commonly affected. S. G. Shattock and W. Anderson have shown by dissection that extension is prevented by shortening of the lateral ligaments chiefly towards the plantar side. The tendons and prolongations of the plantar fascia are normal. In the *treatment* of this condition the toe may sometimes be straightened by subcutaneous division of any resisting structures opposite the head of the second phalanx, but the relief given is often imperfect and seldom permanent. Amputation of the deformed toe has consequently frequently been recommended and performed, but this has the disadvantage of leaving the outer side of the great toe unsupported, and thus giving rise to hallux valgus. W. Anderson recommends excision of the head of the first phalanx by a longitudinal incision on the dorsum of the deformed toe. This leaves the toe straight and ankylosed, but completely relieves the deformity.



Congenital Hypertrophy of Toes and Foot.
Fig. 662.—Plantar Aspect. Fig. 663.—Dorsal Aspect.

Under the name of *hallux flexus* Davies-Colley has described a contraction of the metatarso-phalangeal joint of the great toe, arising in some cases apparently as the result of traumatic inflammation of the joint, and in others from wearing too short boots. The proximal phalanx is flexed to an angle of from 30° to 60° and is incapable of extension; the distal phalanx is in a straight line with the first. The metatarso-phalangeal joint is usually slightly enlarged. The deformity greatly cripples the patient, obliging him to walk on the outer side of the foot. Davies-Colley has found the most efficient treatment to be excision of the proximal half of the first phalanx through a longitudinal incision made at the upper aspect of the inner border of the toe. A stiff joint results, but this causes little inconvenience. In milder cases the application of a proper apparatus may effect a cure.

Supernumerary and Webbed Toes are sometimes met with. It is comparatively seldom, however, that any operative interference is required in these cases. Should it be, the remarks that have been made at pages 524 and

526, in reference to the treatment of these conditions in the hand, are equally applicable here.

Congenital Hypertrophy of the Toes and Foot, as represented in Figs. 662 and 663, occasionally occurs. This malformation is of necessity incurable.

Weak Ankles not uncommonly occur in rickety children ; the ligaments being relaxed, the joints appearing to be swollen, and the child being unable to walk or stand without great difficulty. In these circumstances, attention to the state of the general health, douching with salt water, with the application of an elastic india-rubber bandage round the ankle, or the use of light iron supports, will be found most useful.

Bow-Leg is often associated with weak ankles. The tibia is seen, and can be felt to be bent with the concavity looking towards the opposite leg. In some cases the shaft of the bone is curved, but in the majority the bend will be found to be a somewhat sharp one, situated at the junction of the lower epiphysis with the shaft, the foot at the same time being turned somewhat out, in the position of valgus. This deformity is in some cases rickety, but in the majority of instances it is purely mechanical, owing to the child, especially if heavy and overfed, having been put on its feet at too early an age or for too long a time.

The **Treatment** consists in reducing the weight of the child by careful attention to diet and by the avoidance of fattening food, giving it rest, and by the application of a pair of light well-padded wooden splints to the inner side of the leg, taking their bearing-points from the inner condyle of the femur and the inner malleolus. These should only be worn at night. If the child is under four years of age this will suffice ; if above this age, a light iron support should be worn during the day, taking its bearings from the same points fitted to a slot in the heel of the boot, and tightly strapped over the convexity of the leg.

DISEASES OF REGIONS.

CHAPTER LV.

DISEASES OF THE HEAD AND NECK.

DISEASES OF THE SCALP AND SKULL.

The Scalp is subject to all those surgical diseases that affect the common integument of the body. But it is more than any other part of the surface liable to two diseases, viz., Atheromatous Cysts and Nævi. These have already been so fully treated of (Cysts, p. 999, Vol. I. ; Nævi, p. 1022, Vol. I., and p. 69, Vol. II.) that their description here would lead to needless repetition.

Pachydermatous Tumour of the Scalp or Molluscum Fibrosum (Vol. I., p. 1012). This disease, of rare occurrence, was first described by John Bell, and subsequently by Valentine Mott as *Pachydermatocele,* more recently by Virchow as *Fibroma Molluscum.* The accompanying cut (Fig. 664), taken from a patient whilst in America, who was afterwards successfully operated on by W. Stokes, in Dublin, gives a good representation of the disease.

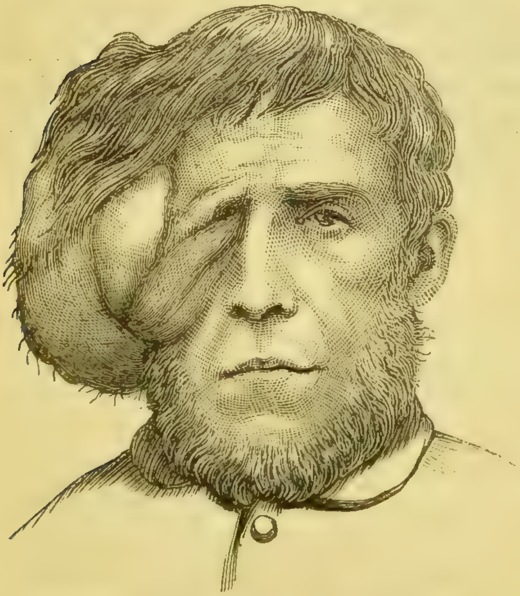


Fig. 664.—Pachydermatous Tumour of Scalp.

These tumours are neither painful nor dangerous, but their weight and the deformity occasioned by them render their removal desirable.

Treatment.—The removal of this tumour may be effected by the ligature or the knife. Pollock has successfully extirpated one by the former, W. Stokes by the latter method. But the operation is not without danger. In Stokes's case the hæmorrhage was described as terrific, nearly costing the patient his life, and had to be arrested by the cautery. Stokes states that in the whole course of his experience he had never seen such copious and uncontrollable "weeping" hæmorrhage ; it came from every point of the cut surface.

Fungus of the Dura Mater.—Sometimes without external or apparent cause, at other times in consequence of a blow or fall, a *Fungous Tumour* grows from some part of the dura mater, usually on the top of the head or in one of the parietal regions. As it increases in size, it produces absorption of the skull covering it ; the bone becomes thin and expanded, and crackles like parchment on pressure, sometimes not being raised above its proper level, but more usually being pushed up by the pressure of the growth beneath, which at last protrudes under the scalp. More usually, this perforation of the skull is gradual; but in some cases it would appear to have been rapid, the first intimation of disease that the patient had being the presence of a tumour under the scalp. When the skull is perforated, the sharp edges of the circular opening can be distinctly felt; and the tumour which protrudes pulsates distinctly, as may be proved both by the finger and the eye.

Pathology.—The nature of these tumours is somewhat uncertain, as sufficient cases have not yet been recorded with an accurate microscopical description of the growth; but it is probable that in the majority of cases they are round- or spindle-celled sarcomata springing from the outer layers of the membrane, which forms the internal periosteum of the skull.

Symptoms.—Symptoms of cerebral disturbance—double vision, optic neuritis, loss of sight, deafness, or epileptic fits, with fixed pain in the head—usually precede for a considerable time the external appearance of the tumour. In some rare cases, no such symptoms have indicated the existence of intracranial disease; and the first evidence of the disease has been the sudden protrusion of a pulsating tumour through the skull. If the tumour be compressed, egg-shell crackling of the expanded and thinned cranial bones will be felt, and, if attempts be made to push it back under the bones, giddiness, syncope, and convulsions are produced. As the disease makes progress, death from paralysis and coma supervenes.

Treatment.—The result of the treatment of fungus of the dura mater is not very satisfactory; yet, as the disease appears to be almost of necessity fatal if left to itself, something should be attempted if possible. The scalp covering it should be turned back by a crucial incision, and the tumour exposed. The aperture in the skull through which it is protruded may then, if necessary, be enlarged by the use of the trephine or Hey's saw, so as to lay bare the full extent of the tumour, which must then be carefully dissected away from the dura mater. In a case in which the operation was being performed by Volkmann, the patient died from the entrance of air during inspiration through an accidental wound of the longitudinal sinus.

Fungus of the Skull also may occur. This term has been applied to any soft fungating tumour springing primarily from the vault of the skull. The growth may spring from beneath the periosteum, when it is usually a small round-celled or a spindle-celled sarcoma, or from the diploë when it is most commonly myeloid. It gives rise to a smooth ovoid tumour on the head, which may or may not pulsate. If it springs from the diploë it is usually covered by a thin layer of bone, which gives the sensation of egg-shell crackling; when it is subperiosteal, it not uncommonly contains a framework of irregular spicula of bone. As the disease progresses it usually perforates the skull, and comes into contact with the dura mater. It is then very difficult to determine whether it arose from that membrane, or merely implicated it by extension. The growth may be mistaken when small for an atheromatous cyst of the scalp, but they are readily distinguished by their being firmly fixed to the bone, while the cyst moves with the scalp. These tumours may become multiple, and after a time be followed by secondary visceral growths. I have twice seen the liver secondarily affected in this way, death resulting without cerebral disturbance from intestinal hæmorrhage and exhaustion. The only *treatment* possible is removal of the growth, but this is accompanied by considerable danger, not only on account of the perforation of the skull and implication of the dura mater, but from the extreme vascularity of these tumours. In a case of this kind, which I had an opportunity of seeing many years ago, the growth was successfully removed by B. Phillips.

Secondary sarcomata and carcinomata are also occasionally met with in the bones of the skull. In a case recorded by Morris a few years ago, a large pulsating tumour of the skull was found to present the structure of the thyroid gland, and was apparently secondary to an enlargement of that body. Three or four similar cases have been recorded by other Surgeons.

Hernia Cerebri, arising from wound or ulceration of the dura mater, has been already described (Vol. I., p. 782).

Congenital Hernia of the Membranes of the Brain is sometimes met with in the form of **Meningocele** or of **Encephalocele.** In the former, the protruded sac is filled with fluid: in the latter, it contains also cerebral substance. The diagnosis between these two conditions is generally difficult; and is of little practical importance. The disease is usually speedily fatal. Z. Laurence finds that, of 39 instances in which it occurred, 21 were males, 18 females; that the protrusion may vary from the size of a pea to that of a tumour exceeding the child's head; and that the occiput is its chief seat—of 79 cases, 53 being in this situation. The hernia may occur at several other points. It has been seen projecting through the anterior fontanelle. In this situation it has most frequently undergone spontaneous cure as the fontanelle closed. Numerous cases have been recorded in which it projected through a deficiency in the region of the cribriform plate into the nasal fossæ, or forwards into the face at the root of the nose, the nasal process and the neighbouring parts of the frontal bone being deficient. Lichtenburg has recorded a case in which it projected from the base of the skull into the pharynx. In these uncommon situations, the swelling may be mistaken for a polypus. In six of the cases collected by Z. Laurence, the subjects of this malformation reached an adult age; in all the remaining cases they died early, or were still-born. Surgery offers little in these cases; though in one instance Paget used injection of iodine with success; and in another, where sloughing of a portion of the tumour was taking place, Annandale applied a ligature to the peduncle, and removed the tumour, the child recovering completely in spite of an attack of measles. In another case, the portion of brain was sliced off, the patient surviving.

Tapping the Head.—This operation has occasionally been performed in chronic hydrocephalus, but so far without much benefit. It is sometimes conjoined with pressure by means of an elastic bandage. It is applicable only to those cases in which, from the early age of the child, or the imperfect ossification of the distended skull, it is possible to compress the head by a moderate degree of pressure. The operation is best performed by means of the aspirator. A fine needle may be pushed through the anterior fontanelle or the coronal suture, avoiding the middle line for fear of wounding the longitudinal sinus. The instrument should be directed away from the middle line so as to penetrate the lateral ventricle, and thus to evacuate a portion of the contained serum. There should be no vacuum in the needle when it is introduced, but when it has penetrated deeply enough to reach the ventricle, the piston of the aspirator may be slowly raised, so as to withdraw the fluid gradually, and not to disturb the circulation through the brain. After a moderate quantity of fluid has been withdrawn, the small aperture should be closed with a strip of plaster, and an elastic bandage should be applied round the head so as to compress and to confine the bones. It is scarcely necessary to observe that the prognosis in these cases is not of a very favourable character.

Operations on the Brain.—Since the clinical and pathological observations and the experimental inquiries of Broca, Hughlings Jackson, Hitzig, Ferrier and others, have made it possible to diagnose the exact seat of many tumours and other lesions within the cranium, and the development of antiseptic surgery has enabled the Surgeon to operate on the brain substance with comparative safety, many such procedures have been undertaken. The general subject of localisation of the functions of the brain has been already sufficiently alluded to in the Chapter on Injuries of the Head (Vol. I., p. 759). The special symptoms of the diseases for which the operations have been undertaken belong rather to medicine than surgery, and cannot be fully described here.

Operations upon the brain have been undertaken for the removal of morbid growths for the relief of epilepsy and for abscess of the brain.

Morbid growths of the brain are either syphilitic or tubercular, or true tumours, the most frequent form of true tumour being the glioma (Vol. I., p. 1032). Sarcomata of various kinds are occasionally met with. True cancer is rare, and only occurs as a secondary growth. Psammoma of the dura mater (Vol. I., p. 1039) may also cause pressure on the brain. All the tumours except the psammoma as a rule implicate the surrounding brain tissue, being rarely accurately circumscribed. The general symptoms of an intracranial tumour may be briefly summarised as signs of irritation or impaired function in that part of the brain in which the new growth is situated, with fixed and persistent headache. Vomiting is a common symptom, and optic neuritis is almost constantly present when the tumour is situated in the substance of the brain. When the growth affects the cortical centres epileptiform seizures are common, and the fit commences by spasm of the part in connection with the centre implicated. In considering the possibility of removal of a tumour of the brain the situation of the growth is of the first importance. It must be so seated that it can be safely exposed by trephining the skull. Tumours at the base, or deeply seated in the brain, are evidently beyond surgical interference, and it is doubtful if the cerebellum can be attacked with safety. If the paralysis is very extensive the growth is implicating so wide an area that its removal probably could not be accomplished or would be speedily followed by recurrence. The nature of the tumour must in many cases be uncertain, but, if it can be ascertained, has an important influence on the question of operation. Tubercular growths are commonly multiple, and are consequently unsuitable for removal, and syphilitic gummata frequently disappear under proper treatment. The evidence of tubercle elsewhere, or a clear history of syphilis, would therefore contra-indicate operation. A true tumour is generally characterised by a slow progressive development of the symptoms, while both tubercular and syphilitic growths may after a time become stationary. The cases suited to operation are undoubtedly rare. Of 54 specimens of intracranial tumour reported on by a committee of the Pathological Society in 1886 only two seemed suited to operation. Trephining for epilepsy has been frequently undertaken as before described (Vol. I., p. 785) in cases of traumatic origin, and in which there has been a painful or tender scar, or some evident depression of the bone ; but it is only within the last two years that portions of the brain have been removed for the cure of that disease. To justify the operation it is necessary that every fit must commence with some definite movement which can be referred to one of the cortical motor centres, or that there should be some paresis or paralysis indicating the part of the cortex affected, without which there can be no guide as to the point at which to apply the trephine.

Trephining for abscess of the brain consequent upon compound fractures of the skull or scalp wounds exposing the bone has been long a recognised operation of surgery. It is, however, but recently that the operation has been undertaken for abscess resulting from disease of the ear, with which disease it will be more fully described.

The results of these operations have so far been singularly successful. In 1883 Macewen of Glasgow successfully trephined two cases guided solely by the present knowledge of the localisation of the functions of the brain. The first case was of traumatic origin and some extravasated blood was removed. In the second the patient had paralysis of the left arm, and trephining over the arm-centre on the right side exposed what was apparently a softening gumma. The first operation for a diagnosed glioma was performed by R. J. Godlee in a case under the care of A. Hughes Bennett in 1884. The patient unfortunately died about a month after the operation from hernia cerebri and meningitis. Since that time the operation has been brought to great perfection and repeatedly performed by Victor Horsley. He has published nine cases in which he removed portions of the brain substance. Three of these were for epileptiform seizures of traumatic origin, and all were cured. Two were for diagnosed tumours of the brain, and both recovered, one dying subsequently of recurrence. One was for a tumour of the cerebellum which proved to be tubercular, the patient dying from the shock of the operation; and the remainder were for cases of epilepsy in which the seat of the irritative lesion was indicated by the part at which the first spasm occurred during the seizure. They all recovered from the operation, and were more or less completely relieved by it.

The details of the operation of trephining and of removal of portions of the brain have been already given (Vol. I., p. 786 *et seq.*). The chief dangers to be apprehended are hæmorrhage during the operation and septic inflammation after it. Hæmorrhage may be to a certain extent controlled, as pointed out by Schäfer and Horsley, by a hypodermic injection of a quarter of a grain of morphia given before commencing the administration of the anæsthetic, as, by this means, a contraction of the arterioles of the brain is induced. Ether must never be used as the anæsthetic for fear of producing congestion. The brain may be safely cut with a sharp scalpel, the hæmorrhage, which is at first very free, being rapidly arrested by gentle pressure with a sponge. The incisions should, as far as possible, be made parallel to the vessels of the part operated on. Septic inflammation can only be prevented by the strictest attention to antiseptic details during the operation and in the subsequent treatment.*

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* For a full description of all the details connected with operations on the Brain, the reader is referred to Victor Horsley's papers in the *British Medical Journal*, of Oct. 9th, 1886, and April 23rd, 1887.

DISEASES OF THE EAR.

AFFECTIONS OF THE EXTERNAL EAR AND MEATUS.—**Malformations** of the lobule are not uncommon. Absence of the pinna or such deformity as completely to close the meatus has also been met with. **Hypertrophy** of the external ear is sometimes met with in idiots; and in gouty subjects, **Tophi,** or **Gouty Concretions,** are occasionally deposited in it. Paget, Bruck, and Vanzetti have described a **Fibrous Tumour** that occasionally forms in the lobule of the ear from the irritation produced by piercing it, as "one of the penalties attached to the barbarism of ear-rings." These tumours are semi-malignant, like the warty growths of cicatrices; and, after excision—their only treatment—are somewhat apt to return.

Bloody Tumours, or Hæmatomata, are occasionally developed without apparent cause in the external ear of the insane or idiots, and are not uncommon in other patients as the result of injury. They may attain a large size, and are often multiple. Unless they become inflamed, I think it better to leave them untouched, when they will gradually be absorbed. If inflamed, they must be opened.

Eczema of the External Ear, sometimes extending into the external meatus, is a common affection. It occurs in scrofulous children and in gouty adults. The constitutional treatment must be conducted on ordinary principles; locally the application of glycerine of borax or of boracic acid ointment, to which a small quantity of extract of belladonna may be added, will be found most useful.

Concretions in the Meatus.—We not uncommonly find that the meatus becomes blocked up by accumulations of wax, dark, indurated, and pipe-like, or forming balls and masses that lie in contact with the membrana tympani. These occur chiefly in individuals of the bilioso-phlegmatic temperament, and are a common source of temporary deafness among young people. They not only materially impair the sense of hearing, but are very apt to give rise to noises in the head, and to crackling sensations on opening and shutting the mouth. Their presence is best ascertained by examination with an ear-speculum. The *Treatment* of these concretions consists in softening the wax by the introduction of a little glycerine into the ear for a few nights, and then repeatedly washing out the meatus by the injection of tepid soap and water, thrown in with a large syringe; as the fluid regurgitates from the membrana tympani, it will at length bring away dark and hardened ceruminous masses.

Thickening of the Cuticle.—Occasionally the cuticle of the external meatus, and that covering the membrana tympani, becomes thickened and indurated, assuming a dull white appearance. This is commonly a result of eczema, and may give rise to some degree of deafness. In these circumstances, glycerine, citrine ointment, or solution of nitrate of silver, will be useful in restoring the healthy condition of the part.

Boils or **Follicular** abscesses are not uncommon in the external meatus. They may arise as a complication of eczema, or as the consequence of irritating discharges from the middle ear. The *Treatment* is to apply hot fomentations to the ear, and, if the boil can be seen, relief may often be given by puncturing it with a small knife.

Diffuse Inflammation of the Meatus or **Otitis Externa** is most common in children, and may occur from a variety of causes, amongst which are measles or scarlet fever, eczema or injuries. In some cases the inflammation affects the periosteum, and in all, unless it be checked early, it tends to implicate the membrana tympani. The symptoms are redness and swelling, more or less completely closing the auditory canal, with intense pain, aggravated in many cases by any movement of the jaw. After a time a purulent discharge escapes, when some relief usually follows. The disease may assume a chronic form with discharge from the ear, forming one of the varieties of otorrhœa. In other cases **abscess** forms which may lead to disease of the bony walls of the canal. In some cases the canal becomes closed by the swelling, and perforation of the membrana tympani may take place. The *Treatment* in the early stages consists of leeches behind the ear, followed by hot fomentations. If suppuration threatens, the pus must be let out early by a free incision made deeply to the bone with a fine knife passed into the meatus.

Exostoses.—Small exostoses occasionally form in the ear, springing from the bony part of the external meatus. These may cause deafness by completely obstructing the canal. They have been successfully treated by Mathewson of New York, Field, Dalby, and others by means of the American dental drill.

Periosteal Thickenings, the result of syphilis, are occasionally met with. These usually disappear under iodide of potassium.

DISEASES OF THE MIDDLE EAR.—It is impossible in a work of this kind to give more than the briefest possible description of the methods of examining the middle ear, and of the affections to which it is liable ; for fuller information the student must refer to special works.

Method of Examination.—For examining the membrana tympani or tympanum from the meatus, the ordinary silver ear-speculum will be found as efficient as any of the more complicated instruments sometimes recommended. The light must be thrown down it by a concave mirror similar to that used for the laryngoscope. If necessary, the ear must first be carefully cleaned by syringing, and afterwards dried by means of small pieces of absorbent wool twisted round the end of a bit of whalebone or wood. The membrane in health is of a bluish-grey colour, and the handle of the malleus can be seen crossing it from above downwards and slightly backwards, terminating a little beyond its middle. The membrane is set at an angle of 45 degrees with the floor of the meatus ; but owing to its concavity looking outwards, a small triangular part below and slightly in front of the end of the handle of the malleus reflects back the light to the eye of the observer, and thus appears as a bright spot. The points to be observed in examining the membrane are its degree of opacity, its colour, and degree of vascularity ; its curvature, whether too concave, or convex and bulging ; and the presence or absence of perforation.

The instrument known as *Politzer's bag* is of great value in examining the condition of the Eustachian tube and the middle ear. It consists of a thick india-rubber bag with a blunt nozzle, and is used thus : the nozzle is inserted into one nostril, and both nostrils are then squeezed between the finger and thumb, so as efficiently to close the anterior nares ; the patient then takes a small quantity of water into the mouth and holds it till directed to swallow ; at the moment he swallows the bag is squeezed, and the upper part of the pharynx above the soft palate is thus distended with air, and as at the same time the Eustachian tubes are opened by the act of swallowing, the air rushes into the cavity of the tympanum. While this is being done the Surgeon connects his ear with that of the patient by means of an india-rubber tube about three feet in length with an ear-piece at each end. He thus hears distinctly the effect produced by the distension of the cavity of the tympanum. The cavity of the tympanum can usually be distended equally well if the patient closes the mouth and pinches the nostrils, and then makes a forced effort of expiration. The following are the chief facts learned from this mode of investigation. In health, the Surgeon hears the air enter the tympanum and impinge on the membrane with a sharp click, sounding to the patient as a loud crack. If the Eustachian tube is closed by swelling or plugged with inspissated pus or mucus also filling the tympanum, this will be entirely wanting. If the cavity is filled with tenacious mucus or muco-purulent fluid, a crackling bubbling sound will be heard both by the Surgeon and the patient as the air enters the cavity. If the membrane is perforated and the Eustachian tube pervious, the air will be heard passing through the aperture.

The *Eustachian Catheter* is useful in treatment rather than in diagnosis. It consists of a small metal or vulcanite tube about six inches in length with a slight curve at one end and expanded at the other to receive the nozzle of the small india-rubber bag used for injecting fluids or air. On the large end is a ring to show the position of the point while it is in the nose. It is thus passed : the concavity of the curve being turned towards the floor of the nasal fossa, so that the point may not hitch against the turbinate bones, the catheter is passed backwards through the nose till it touches the posterior wall of the pharynx. It is then withdrawn about half an inch and its point directed outwards and slightly upwards against the orifice of the Eustachian tube. The Surgeon having his ear connected with that of the patient by the india-rubber tube before described, can then ascertain whether the catheter is in the tube or not by blowing some air through it from a small india-rubber bag.

In order to ascertain the degree of hearing, a watch or tuning fork is commonly used. The distance from the ear at which the ticking of the watch can be heard is generally taken as the indication of the degree of deafness. If the vibrating tuning fork or the watch be pressed against the vertex, in health it is heard equally well in the two ears ; if one meatus or one Eustachian tube be blocked, the sound will be heard more loudly in the affected ear ; if the sound cannot be heard with the instrument in this position, or is heard very imperfectly, the deafness is due to disease of the nervous apparatus of the ear.

The diseases of the middle ear are commonly classed under the following headings : Simple Mucous Catarrh and Purulent Catarrh, and each of these is divided into acute and chronic.

Simple Acute Catarrh is usually associated with catarrhal affections of the pharynx, and is most common in children. It is characterized by acute hyperæmia and swelling of the mucous membrane with increased secretion of mucus. Difficulty of hearing is an early symptom, and in some cases there is intense ear-ache radiating over the side of the head. Noises and throbbing in the ear are seldom absent. Examination of the ear shows the external meatus clear, some redness of the membrana tympani, with bulging in some cases. If left unrelieved the membrane occasionally perforates, after which cure takes place and the aperture heals, or the disease may become chronic. The *Treatment* in mild cases consists of the application of leeches behind the ear, and hot fomentations externally. At the same time the air should be blown into the tympanum at intervals by means of Politzer's bag; the mucus will usually escape when the air regurgitates from the cavity. If there is much bulging and acute pain, relief can be obtained more surely, and the risk of permanent damage to the ear avoided by puncturing the membrane by means of a small lancet-shaped knife specially constructed for this purpose, or a cataract needle. This operation is easy of performance; the speculum having been passed, and a good view of the membrane obtained, the puncture is to be made at the lower part of the membrane behind the handle of the malleus. The mucus may then be blown out by means of air-douches from Politzer's bag, or through the Eustachian catheter. The operation is usually followed by complete relief, and the small puncture soon heals, leaving the hearing unimpaired.

Chronic Non-Purulent Catarrh is a very common disease and a frequent cause of deafness. Two varieties are described—the dry and moist. Dry catarrh is a term applied to a chronic inflammation of the mucous membrane unaccompanied by any excess of secretion. It leads to thickening of the mucous membrane, and finally causes deafness from immobility of the ossicles. In moist catarrh there are swelling and hyperæmia with excessive secretion. It often affects the Eustachian tube chiefly, and may lead to its contraction or closure. If this takes place, the air in the tympanum soon becomes absorbed, and the membrane becomes abnormally concave. Noises in the ears and occasional pain are common. It is most commonly associated with pharyngeal catarrh. This condition is the common cause of so-called Eustachian or throat deafness. The treatment of chronic catarrh is usually not very satisfactory. The general health must be attended to, and the catarrh of the pharynx relieved by astringent applications, as nitrate of silver, glycerine of tannin, &c. At the same time the air must be blown into the tympanum at intervals by Politzer's bag, the Eustachian catheter, or by forced expiration with the nostrils closed. By this means the strain on the membrane is relieved and the mucus allowed to escape. Astringent injections into the tympanum by means of the catheter have been used, but their benefit is somewhat uncertain.

Acute Purulent Catarrh is commonly a sequela of scarlet fever or measles. The symptoms may be acute like those of the acute non-purulent form already described, or perforation of the membrane may occur without any acute symptoms having manifested themselves, the first symptom being the discharge from the ear. After the pus has thus found exit the opening in the membrane may close and recovery take place, but in scrofulous children the suppuration may become chronic. It is very important in all cases of scarlet fever or measles, especially in scrofulous children, to keep a careful watch on the ear, as in many cases the complete destruction of the membrana tympani and loss of the ossicles might be prevented by early incision.

Chronic Purulent Catarrh may arise as a sequel of acute inflammation of the middle ear, or as the result of extension from without in diffuse inflammation of the meatus. In these cases the membrana tympani is always perforated. The symptoms are merely loss or dulness of hearing, with a chronic muco-purulent discharge from the ear, often having an extremely offensive smell. The consequences of purulent catarrh are frequently serious, and sometimes fatal. If unchecked the disease may lead to necrosis of the small bones, or to their becoming ankylosed and fixed by adhesions to such an extent as to be useless. The disease probably in all cases extends into the mastoid cells, and here the discharge may accumulate and decompose. Owing to the irregularity of the cavities it may not find a sufficient exit, and an abscess of the mastoid process may form, gradually perforating the bone and appearing beneath the skin. Caries or necrosis of portions of the temporal bone is a consequence of greater gravity. When this takes place, or sometimes without actual disease of the bones, pus may form within the skull between the dura mater and the bone. This may be followed by diffuse septic meningitis, or by thrombosis of the lateral sinus, with subsequent softening and disintegration of the clot, giving rise to embolic pyæmia. **Abscess of the Brain** is a complication occasionally met with, apparently as a consequence of septic phlebitis. It is most commonly seated in the temporo-sphenoidal lobe, but when the mastoid cells are implicated it may form in the cerebellum. It is said to be more common above the tentorium in children and below in adults. In rare cases fatal septic infection may take place without any disease of the bone being found after death. In strumous children enlargement and suppuration of the glands behind the jaw is a common complication. An abscess of the brain is characterised by many of the same symptoms as a tumour, the most marked being headache, vomiting, gradually increasing insensibility and optic neuritis. As the abscess does not, as a rule, implicate the motor area of the cortex, localisation is very uncertain. A very slow pulse and a temperature often below normal are very characteristic symptoms. The symptoms as a rule come on slowly and insidiously, but their onset may be marked by a severe rigor. Unless relieved by treatment abscess of the brain is necessarily fatal, the patient either gradually becoming comatose or dying somewhat suddenly as if from apoplexy, apparently from bursting of the abscess into the ventricles.

In the **Diagnosis of Abscess of the Brain** after ear disease we must be guided chiefly by the slow pulse, low temperature, and optic neuritis. The other symptoms may equally arise from septic thrombosis or meningitis. The low temperature will serve to distinguish it from pyæmia. Moreover, in pyæmia the rigors are commonly repeated at irregular intervals. In many cases, however, the diagnosis is very difficult. In rare cases fatal septic infection may take place without any disease of the bone being found after death. In strumous children enlargement and suppuration of the glands behind the jaw is a common complication.

In the **Treatment of Chronic Purulent Catarrh** of the middle ear, the essential objects aimed at are complete removal of the purulent secretion as soon as it forms, and prevention of its decomposition. As the secretion diminishes, astringent applications may be used to hasten its cessation. The removal of the purulent secretion is effected chiefly by frequent syringing of the ear with some antiseptic solution, and by blowing through the cavity either by Politzer's apparatus, the catheter, or simple forced expiration. The syringe must not be used forcibly, especially if the opening in the membrane is large. Hinton recommended that an india-rubber ball syringe with a nipple-like nozzle completely filling the external meatus, should be used, by means of which the fluid may be made to flow through the ear into the pharynx. This should be done with steady gentle pressure. If too much force be used it causes giddiness or faintness. The head should be held forwards, so that the fluid that enters the pharynx may pass out at the nose. Decomposition is prevented by the use of antiseptic solutions, the best being Condy's fluid, chloride of zinc (gr. j. to ℥j.), or a concentrated solution of boracic acid. After the ear has been syringed the meatus should be carefully dried with cotton-wool. In many cases great benefit is obtained from blowing into it a small quantity of iodoform. When the opening in the membrana tympani is of sufficient size the cavity of the tympanum may be cleaned out by means of a fine probe with some cotton-wool wrapped round it.

Under this treatment the discharge in most cases gradually ceases, and unless it be too large, the opening in the membrane heals. In cases in which there is insufficient exit for the discharge it may be necessary to enlarge the opening in the tympanic membrane to allow of more perfect cleaning of the cavity.

The complications of chronic purulent catarrh must be prevented if possible by the above treatment. Necrosis of the petrous portion of the temporal bone, diffuse meningitis and pyæmia, when they arise, are beyond the reach of treatment. Necrosis of the mastoid process is less dangerous; the sequestrum may separate and be removed by the meatus or externally. If there is pain, redness and œdema over the process, indicating pent-up pus in the mastoid cells, a free incision must be made upon the bone. It should be placed about half an inch behind the ear, curving slightly forwards at the upper part above the attachment of the auricle, and terminating below at the tip of the mastoid process. The pinna is then pulled well forwards and the bone exposed and examined. In rare cases it may be found that an opening has already formed, which must then be enlarged with a gouge. More commonly the periosteum is loosened or raised by pus without any opening existing. The mastoid cells must then be opened. The part to be first exposed is the so-called mastoid antrum, the largest of the cells which opens into the posterior part of the tympanum by a wide mouth. To reach this the bone must be cut away with a small gouge, commencing on a level with the upper margin of the external auditory meatus and about a quarter of an inch behind it, the gouge being directed inwards and forwards. After cutting away a comparatively thin layer of bone the antrum is reached, after which the remaining cells may be broken into with a strong probe. All inspissated pus and granulation tissue may then be cleaned out with a small sharp spoon. Various special instruments have been devised for cutting away the bone, such as small trephines and drills, but the operation is much more safely performed with a gouge and mallet. If the bone be cut away too far back, there is danger of wounding the lateral sinus, and for this reason the instrument must never be directed backwards. After the cells are opened, it is advisable in some cases to cut away part of the bony wall of the meatus. A metal or india-rubber drainage-tube is then inserted and some antiseptic solution syringed through it daily. By the timely performance of this, many patients may be saved from the dangers of intracranial suppuration.

When symptoms of intracranial suppuration manifest themselves, it is advisable to open the mastoid cells and to clean out the tympanum thoroughly before proceeding further. If the pus lies between the dura mater and the bone, it is possible that it may be reached and let out by cutting away the bone so as to expose the dura mater, great care being taken not to wound the lateral sinus. If the symptoms point clearly to cerebral abscess, the only chance of saving the patient is to trephine and to let out the pus. This operation has been performed by Hulke, Barker, Caird, and Macewen.

The first successful case was that performed by A. E. Barker on a patient under the care of Gowers. The abscess contained nearly an ounce of fœtid pus, yet the patient perfectly recovered without any apparent impairment of function. Barker recommends that the mastoid foramen should be examined as a preliminary step. If the vein passing through it is thrombosed, or if pus is escaping beside it, it is probable that the collection of pus is below the tentorium. If there is reason to believe the abscess is in the temporo-sphenoidal lobe, Barker advises that the pin of the trephine be placed an inch and a quarter above a line drawn from the lower margin of the orbit through the centre of the meatus of the ear, and the same distance behind the centre of the auditory meatus. The dura mater must be divided, any branches of the meningeal artery being ligatured and the substance of the brain examined by means of a hollow needle thrust in various directions. If pus is found, the opening may be enlarged by means of sinus-forceps, and a drainage-tube inserted. A metal tube about the size of a No. 8 catheter was used in Barker's case and found to keep in better than the ordinary india-rubber tube.

If the abscess is in the cerebellum Barker has found by observations on the dead body that the best point to apply the pin of the trephine is an inch and a half behind the centre of the meatus, and an inch below a line drawn from the lower border of the orbit through the centre of the meatus of the ear. This will avoid the lateral sinus completely. The bone is exposed by an incision carried backwards from the mastoid process along the superior curved line of the occipital bone for about two inches. The periosteum and soft parts are then stripped off with an elevator till the inferior curved line is exposed, immediately below which the opening may be made. The bone here is excessively thin, and can be easily broken through with a gouge. These operations should be performed with the strictest antiseptic precautions.

Otorrhœa.—This is merely a name for a muco-purulent discharge from the ear. As already pointed out it may arise from diffuse inflammation of the external meatus, from badly treated abscess of the meatus, from catarrh of the middle ear with perforation of the membrana tympani, and from disease of the petrous portion of the temporal bone or mastoid process. The vast majority of cases arise from the middle ear. Disease of the bones is very rarely primary, being almost always a secondary consequence of disease of the mucous membrane. The treatment has already been described.

Polypus.—Polypi of the ear, in the great majority of cases, spring from the tympanum, and project through an opening in the membrana in cases of chronic aural catarrh. They are rarely met with springing from the external meatus. They are usually firm and fleshy-looking, though sometimes soft and gelatinous, and composed simply of granulation-tissue; sometimes pedunculated, but at others situated on a broad base. They produce serious inconvenience by obstructing the external ear, and require to be twisted off by means of forceps, or, if too firmly fixed for this, cut off with scissors or a wire snare; after which means must be taken to cure the purulent catarrh upon which the growth is dependent.

Nervous Deafness is recognized by the absence of the symptoms of any of the foregoing diseases, or of the history of their occurrence, and by the fact that a vibrating tuning fork is either not heard at all or imperfectly heard when it is placed upon the vertex or between the teeth. As it is not amenable to surgical treatment, it is needless to discuss here its causes or pathology.

DISEASES OF THE NOSE.

External Affections of the Nose.—**Acne Rosacea** is an affection of the skin of the nose, in many cases distinctly resulting from alcoholic excess, in others, especially in women, being apparently connected with chronic dyspepsia. It commences as a red spot on which dilated capillaries are visible, and extends gradually over the whole tip of the nose and often to the adjacent parts of the face. At first the sebaceous follicles are not affected, but later on they usually become enlarged, making the surface more or less tuberculated. Some thickening of the skin usually occurs at this stage. The *treatment* consists in correcting evil habits in drinking or eating, and attention to the digestion and general health. Locally, iodide of sulphur ointment is useful.

Lipoma Nasi is a chronic hypertrophy of the cutaneous and subcutaneous structures, forming a large reddish-blue, vascular-looking, soft, tremulous, and lobulated mass, enveloping the end of the nose, and producing excessive deformity of it. There are all degrees of this disease, from mere clubbing of the end of the organ, to the formation of a set of pendulous lobular tumours attached to it. The sebaceous glands are greatly enlarged in this disease, often reaching the size of small peas. The patient's appearance may be greatly improved by the removal of these growths, as is shown in Figs. 665, 666, taken from a patient operated on in University College Hospital. This may be done readily enough by making an incision down the mesial line to the alar cartilages, and then dissecting the lipoma off these on each side; especial care, however, being taken in doing this not to encroach upon the nostril. This is best avoided by directing an assistant to keep his finger in it while the dissection is being prosecuted, so that he may warn the Surgeon of the too near approach of the knife. The surface is then left to granulate and cicatrize.

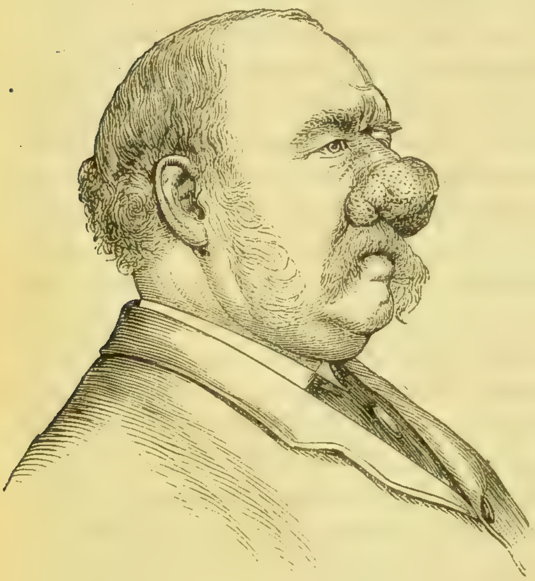


Fig. 665.—Lipoma of Nose before operation.

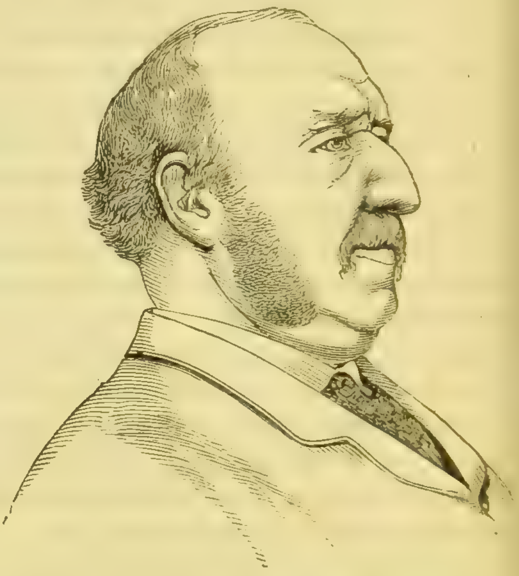


Fig. 666.—Same Nose after Operation.

Lupus, Epithelioma, Rodent Ulcer, and Tertiary Syphilitic Ulcera-

tion are all common in the nose. Lupus especially may be looked upon as almost specially affecting this organ, destroying one or both alæ, the columna, or perhaps the whole of the nose. The consideration of the nature and treatment of these affections in this situation presents nothing special (*see* Chapter XXXVII., Vol. I.) ; but the cure of the deformities induced by them, which is full of interest to the Surgeon, will be considered in detail when we speak of the plastic operations that are practised on the face.

Ulcers and **Fissures,** of a less serious character, though very painful and chronic, often occur at the angle of the ala and septum, or between the ala and tip. Their *Treatment* consists in touching them from time to time with nitrate of silver, or in the application every night of white precipitate or citrine ointment ; at the same time that the general health is attended to, and the strength restored, by the administration of iron, bark, and sarsaparilla.

AFFECTIONS OF THE NASAL CAVITY.—**Examination of the Nasal Cavity.**—The nasal cavity may be examined from the front by means of the nasal speculum. This is introduced so as to dilate the nostril, and a strong light is then thrown in by means of the laryngoscopic mirror. The speculum shown in Fig. 668, will be found most convenient, as it does not require holding, and thus leaves the Surgeon's hands free. The posterior nares can be examined by the laryngoscope, the mirror being held in the reversed position. The patient is placed in the same position as for examining the larynx (see Diseases of the Larynx), but the tongue is not drawn out. The uvula is then drawn forward with a small curved spatula, or the patient may be told to bend the head slightly forwards, breathe out through the nose, and say "*on*" nasally as in French. The mirror is then inserted till it is close to but not touching the posterior wall of the pharynx. The handle may be slightly bent with the concavity of the curve towards the tongue. The mirror should be of small size, and should be joined to the stem at a very obtuse angle. It should be passed first on one side and then on the other of the

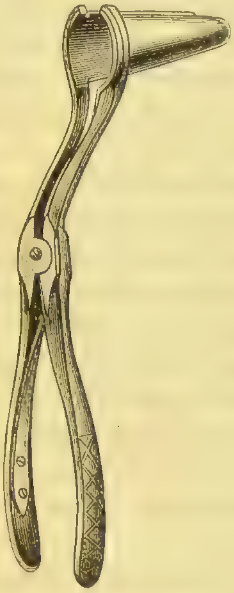


Fig. 667.—Nasal Speculum.

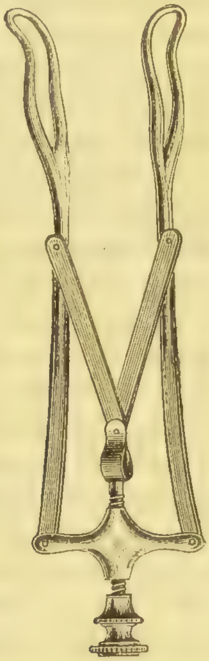


Fig. 668.—Fränkel's Nasal Speculum.

uvula, the shank being used to depress the tongue, or if that organ is difficult to control, a tongue-depressor should be used with the left hand, whilst the mirror is held in the right. The examination is much facilitated by rendering the parts insensible with a 20 per cent. solution of cocaine applied with a brush. The posterior nares can be examined also digitally by passing the finger behind the soft palate.

Deviation of the Septum.—This may be the result of injury or a congenital malformation. It is seldom of any importance, but should it exist to such an extent as to obstruct one nostril it may be necessary to remedy the deformity by operation. This may be done by forcibly bending the septum into its proper position by some blunt instrument passed up the nostril. Should this be impossible, the part of the cartilage obstructing the nostril may be cut away, care being taken not to remove so much as to cause sinking in of the nose.

Chronic Catarrh, in the form of a thin watery mucous discharge, lasting for many months, is occasionally met with, more particularly in young women, independently of any structural disease of the mucous membrane. The *Treatment* of this affection consists in the employment of tonics and means calculated to strengthen the system generally, and the local application of astringents, such as tannin, chloride of zinc, &c. But under any plan of treatment this affection is apt to prove rebellious.

Follicular Hypertrophy.—Meyer of Copenhagen has described a condition occasionally met with in strumous children, in which there is a general overgrowth of the lymphatic follicles situated about the posterior nares and upper part of the pharynx. It leads to more or less complete obstruction of the posterior nares, and is often accompanied by deafness. The condition can be recognized by the nasal tone of the voice, the stoppage of the nose, and by the enlarged follicles being felt with the finger passed behind the soft palate. Meyer recommends that the enlarged follicles should be scraped away by means of a ring-shaped knife set in a long handle, which can be passed through the nostril and guided by the finger behind the soft palate. More commonly Löwenberg's forceps or a sharp finger nail are used.

Watery Discharge from the Nose.—Sir James Paget has recorded a case in which a clear watery fluid of a specific gravity of 1004, containing a trace of albumen and a considerable quantity of chloride of sodium, flowed steadily at the rate of a drop every five or six seconds from the left nostril. The fluid exactly resembled cerebro-spinal fluid. Following the practice of Sir Benjamin Brodie in a similar case, Sir James Paget administered sulphate of zinc internally, and injected the nostril with a solution of the same substance, and under this treatment the discharge ceased. The flow commenced six months after a severe blow on the forehead. The patient subsequently died of meningitis, the inflammation being most marked about the under surface of the frontal lobes, but no communication was found between the nasal fossæ and the subarachnoid space. In the left antrum, however, were found two broad-based polypoid growths which Sir James Paget believes to have been the source of the discharge.

Ozæna.—By the term ozæna is meant a chronic muco-purulent discharge from the nose, having a peculiar and most offensive smell. It may arise in some cases without evident cause, and is then called *simple;* but more commonly it is due to *syphilitic* or *strumous* disease in the nasal fossæ, accompanied by ulceration of the mucous membrane or necrosis of the bones. The *treatment* necessarily varies with the cause of the disease, and will be discussed with the affections that give rise to it, but from whatever cause it may arise the nasal cavity must be thoroughly washed out twice a day at least to remove the offensive discharge. This can be done efficiently by means of the "*nasal douche*." This consists of an india-rubber tube about three feet long, to one end of which is fixed a nipple-like nozzle to fit into the nostril, and to the other a metal tube bent into the shape of a syphon. It is thus used. The tube is first filled with water and the syphon end hung over the edge of a jug or tumbler containing the fluid to be injected into the nose. The patient then holds his head over a basin, and breathes through the mouth, which must be kept open. The nipple end of the tube is now placed in the nostril, and the vessel holding the fluid to be injected is raised about two feet above the head of the patient. The fluid will then flow through the syphon and enter the nostril with a degree of force proportional to the height at which the vessel is held. As the patient is breathing through the open mouth, the soft palate is curved backwards against the posterior wall of the pharynx, and shuts off the nasal part of that cavity; the fluid, therefore, passes out at the opposite nostril, thus washing out both nasal cavities and the part of the pharynx above the soft palate. The fluid used should contain some antiseptic, as Condy's fluid, chloride of zinc (gr. j to ℥j); a concentrated solution of boracic acid, or sulphate of zinc (gr. ij to ℥j). After the nose has been thoroughly cleaned, a deodorizing solution may be blown into it by a nasal spray apparatus, which should be fitted with nozzles adapted either to the posterior and anterior nares. In using the former the nozzle must be passed up behind the soft palate. G. V. Poore recommends the following powder to be taken as snuff; biborate of soda, nitrate of bismuth, aa ʒj; disulphate of quinine, gr. x; iodoform, gr. v.—The snuff may be used two or three times a day, care being taken to wash it out thoroughly each day with the nasal douche.

Simple Ozæna.—A very fœtid discharge from the nose will occasionally occur in delicate or strumous children while cutting their teeth, and may continue for several years. It may arise also after one of the acute specific fevers, especially scarlatina or measles. Sometimes it occurs at a later period, chiefly in women. The mucous membrane is swollen and red, but the disease is not necessarily attended by ulceration, although this may take place if the foul discharge is allowed to accumulate. The *Treatment* consists in the use of the nasal douche or spray, after which some astringent application may be applied. Glycerine of tannin will often be found of great use. It may be applied by means of a camel's-hair pencil through the nostrils, and in most cases it is necessary also to pass a long brush on a bent stem from the mouth behind the soft palate, so as to reach the upper part of the pharynx and the posterior nares. In young children the teeth and stomach must be attended to.

Chronic Thickening of the Schneiderian Membrane, or **Hypertrophic Catarrh.**—The mucous membrane of the nose is not unfrequently chronically inflamed, especially in strumous children; that portion of the membrane covering the turbinate bones becoming thick, soft, and vascular, and projecting like a broad fringe from their surface. It is usually of a bright red colour, and covered with muco-pus without offensive odour.

This swelling at all times produces snuffling and a peculiar intonation of voice, but increases in wet weather, and then may become so great as seriously to obstruct the breathing.

Nasal Reflex Neuroses.—Chronic nasal catarrh with hypertrophic changes in the mucous membrane occasionally gives rise to various reflex nervous phenomena, amongst which may be asthma, spasmodic sneezing and cough, megrim, supra-orbital neuralgia, vascular disturbances causing redness and swelling of the tip of the nose and adjacent parts of the face, vertigo, and it is said even epilepsy. These are said to be always accompanied by hyperæmia of the excessively vascular, almost erectile tissue which exists in the mucous membrane of the free edges of the inferior and middle turbinate bones which can be recognised on examination by means of a speculum. A cure may be effected by the destruction of the swollen mucous membrane with the galvanic cautery, or by the application of a strong caustic, such as chromic acid. There can be little doubt that the frequency of these reflex neuroses has been greatly exaggerated by some enthusiastic specialists, particularly in Germany, but at the same time the evidence that they occasionally occur is practically conclusive. In all cases, therefore, in which the above conditions are met with, the nasal cavities should be examined, and if the mucous membrane covering the margins of the turbinate bones appears swollen or thickened, it may be cauterized with a fair hope of giving relief.

Abscess occasionally forms either in the mucous membrane or on the septum, and thus may lead to necrosis of the cartilages and bones, separation of these, flattening of the nose, depression of its bridge, and great deformity. These various forms of abscess, followed by necrosis, are commonly syphilitic, and result from softening gummata beneath the mucous membrane or periosteum, and are associated with ulcers and a foul and fœtid discharge, which has a tendency to cake upon the surface, forming dark and rugged crusts, constituting the condition known as *Syphilitic Ozæna.* A similar condition may be met with also without any evidence of syphilitic infection. This most commonly occurs in strumous subjects, and is usually associated with enlargement of the glands at the angle of the jaw. Such a condition would be described as *Strumous Ozæna.* Ulceration in the nasal cavity may in some cases be consequent upon the irritation of decayed teeth, producing disease of the antrum, and escape of morbid secretion from this into the cavity of the nose.

The *Treatment* of these conditions must be conducted by the use of the nasal douche or spray, followed by the application of solution of nitrate of silver, sulphate of copper or bichloride of mercury, one or two grains to the ounce. The snuff above mentioned will often be found very useful. In extreme cases it may be necessary to destroy the hypertrophied mucous membrane covering the inferior and middle spongy bones by the galvanic cautery or by the application of some caustic, chromic acid being one of the best. If this is not successful, a portion of the spongy bones may be removed so as to restore the passage through the nose. In syphilitic cases the general treatment of syphilis must be carried out, iodide of potassium or mercury being administered according to the condition of the patient. In strumous cases, codliver-oil and iodide of iron are most useful. When necrosis occurs, it must be treated as described below.

Necrosis not unfrequently occurs in the loose bony structures lying in the nasal fossæ or in the nasal bones themselves. In these cases the septum nasi participates in the morbid process, and commonly separates or is perforated.

Necrosis may occur in these situations either as the result of syphilis, the abuse of mercury, or from external injury. It is also met with in workers with arsenic or chromic salts. I have, however, seen cases, more particularly in women and children, which are not referrible to any of these causes, or indeed to any other external exciting cause, and in which scrofula was probably the occasion of the disease. Perforation of the septum has been observed also as a congenital malformation.

The presence of the necrosis may be suspected from the great fœtor that infects the breath, of which the patient himself is unconscious ; and its existence may always be positively determined by exploration of the nasal cavities with a probe.

The *Treatment* is simple, and must be conducted on ordinary medical and surgical principles. If the general health be impaired, or if the disease be specific, appropriate constitutional treatment must be adopted. The fœtor may be lessened by the nasal douche and antiseptic applications. As soon as the bone is loosened, it must be extracted with polypus-forceps, coming away in soft black crumbling, offensive masses. There is often abundant hæmorrhage after this extraction, but I have only once seen serious trouble result from this cause. The patient, who was of intemperate habits, suffered from extensive destruction of the hard palate and bones of the nose. An attempt was made to remove a sequestrum, when a sudden gush of blood took place which rapidly proved fatal, partly by entering the lungs and partly from syncope. If hæmorrhage occurs, plugging will in most cases easily arrest it.

In cases of obstinate ozæna in which necrosis is suspected, or in which the sequestra cannot be removed by the nostril, Rouge, of Lausanne, recommends that the nasal cavity should be opened by an incision made from the mouth at the reflection of the mucous membrane from the gums to the upper lip. The cartilages are separated, and the septum cut through with strong scissors sufficiently to allow the upper lip and nose to be pulled upwards for a sufficient distance thoroughly to expose the nasal cavity. By removing sequestra in this way, Rouge cured several cases of most obstinate ozæna. After the operation the nose is replaced, and no scar or other deformity results.

Calculi, or **Rhinoliths**, are occasionally met with in the nasal fossæ, where they simulate foreign bodies, and may keep up considerable irritation and offensive discharge ; and here extraction may be practised with a pair of forceps. But sometimes they are situated under the mucous membrane. In two cases I have dissected round calcareous bodies of this kind, of about the size of cherry-stones, from under the mucous membrane of the ala of the nostril in children.

Epistaxis, or bleeding from the nose, is very common in children and in young people about the age of puberty, more particularly in girls, antecedently to the menstrual period ; it may either be active or passive, but is most usually dependent on congestion of the mucous membrane. In the adult it is more serious, and it may then be dependent on one of two very opposite conditions —either on a state of plethora with tendency to cerebral congestion, or on an anæmic and cachectic state, in which the blood is thin, and does not coagulate readily. In the first condition, when occurring in the young and plethoric, it is often a salutary relief to the system. But when occurring in cachectic, anæmic, and especially aged people, it becomes of very serious moment; and in such circumstances the loss of blood may be so continuous and copious that, unless active means be adopted, a fatal termination may ensue. When epistaxis proves fatal, it is by its constant recurrence. In these cases, I believe, the nasal hæmorrhage is always associated with a broken-down and unhealthy state of the constitution, dependent upon chronic visceral mischief, especially chronic Bright's disease, with the contracted kidney and cirrhosis of the liver. The worst and most intractable cases that I have seen have been connected with hepatic disease and jaundice. Epistaxis is in some cases associated with purpura; more rarely it occurs in patients suffering from hæmophilia. It is sometimes a prominent symptom in sarcoma of the bones of the nose.

Treatment.—Epistaxis must not be treated simply as a local disease of the nose. It is usually only a symptom of some constitutional condition or visceral disease that requires remedying before the hæmorrhage can be expected to cease. Hence it is of the first importance to treat on ordinary medical principles those states of plethora or cachexy with which it may be associated, or those conditions of disease of liver or of kidney that are met with in persons suffering from it.

In young people, otherwise healthy, and in slighter cases, epistaxis may commonly be arrested by the employment of ordinary domestic means, such as pinching the nostrils between the finger and thumb or the application of cold to the nape of the neck and forehead; and its return may be prevented by the use of purgatives, or in girls by attention to the proper regulation of the menstrual function.

In plethoric adults the flow should not be too suddenly checked, especially if the pulse be very hard and incompressible. Should it prove very abundant, dry cupping between the shoulders, and the application of an ice-bag to the forehead, with rest, will be required.

In anæmic and cachectic subjects, and in old people, the hæmorrhage is often attended by dangerous consequences, and requires the use of active measures for its suppression. In these cases the following plan should be adopted. The head should be raised, an ice-bag applied to the forehead, complete rest and quietude enjoined, and gallic acid in ten-grain doses, or half-drachm doses of the tincture of ergot or of tincture of hamamelis, administered at frequent intervals. Should the bleeding still be profuse and continuous, a current of iced water may be made to flow through the nose by means of the nasal-douche, or the interior of the nose may be sponged out with a solution of perchloride of iron or tannin. If the nose be carefully dried with cotton-wool and examined with a speculum, it may happen that a definite bleeding point can be seen to which the actual cautery or some styptic solution can be applied. If none of these means succeed, it will become necessary to plug one or both nostrils. This may be done by carefully pushing into the nostril some strips of lint soaked in a strong solution of tannic acid. Each strip should have a string attached to it to make sure that it is not lost in the nasal cavity. A piece of dried sponge, having a quill or a piece of gum catheter passed through it for breathing purposes, may be used instead of lint. Perchloride of iron should only be used as a last resource, as it is apt to cause ulceration of the mucous membrane. Various forms of nasal tampon have been devised; the essential feature of all being a thin india-rubber bag, which can be introduced in the collapsed state into the nostril and distended with air or water. If any one of these be at hand it forms by far the best means of plugging the anterior nares.

Should the hæmorrhage still continue, the blood passing back into the throat, and perhaps being swallowed, the posterior nares require to be plugged as well. This operation should, however, be deferred until it becomes absolutely necessary for the preservation of life. Plugs in the posterior nares behind the soft palate are a source of very great distress to most people, and in old persons will rapidly wear out the powers of life by interference with breathing and sleep. I believe that by attention to proper constitutional and by perseverance in other and milder local treatment plugging of the posterior nares may commonly be avoided. When absolutely required it is best done by carrying a long piece of strong whip-cord along the floor of the nose

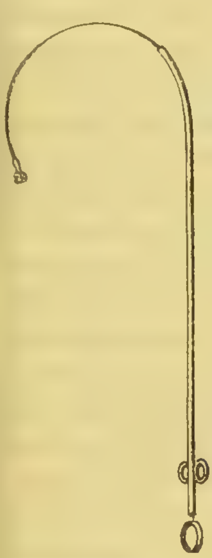


Fig. 669.—Bellocq's Sound.

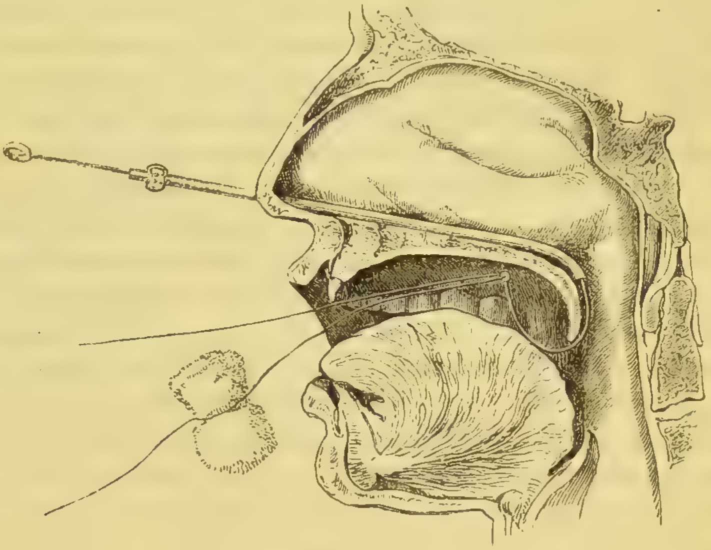


Fig. 670.—Diagram of Plugging the Nostril by means of Bellocq's Sound.

through the posterior nares into the pharynx, by means of Bellocq's sound (Fig. 669), or, if this be not at hand, by threading the cord through an elastic catheter, and carrying this into the pharynx, then seizing the cord as it appears behind the soft palate, and drawing it forwards into the mouth, at the same time that the catheter is taken out of the nostril. In this way the string will pass through the nose, round the back of the soft palate, into and then out of the mouth (Fig. 670). To the middle of the piece of string that hangs out between the lips, a plug of lint, about the size of the first joint of the thumb, or better still, a piece of compressed sponge, should be firmly tied; this is then drawn up into the posterior nares by pulling on the end of the ligature that hangs from the nose, being guided in its passage behind the palate by the fingers introduced into the mouth. When the bleeding has ceased, it may readily be withdrawn by means of the string that hangs out of the mouth. As the epistaxis is very apt to recur, it is a wise precaution, when the plug is removed from behind the palate, to leave a loop of string in the nose and mouth, which may be knotted and fixed by a slip of plaster behind the ear. In this way the plug may, if occasion occur, be readily replaced without the necessity of re-introducing the sound or catheter through the nose, which is often a troublesome operation.

TUMOURS OF THE NASAL FOSSÆ.

POLYPUS.—Tumours of very different structure and composition are met with in the nostrils : and to all of these which possess the common characters of being pendulous and blocking up these passages, the term *Polypus* is given. Thus Surgeons commonly speak of the *Benign*, the *Soft*, the *Gelatinous*, or *Mucous Polyp*, as well as the *Sarcomatous* or *Fleshy*, and the *Malignant Polyp*. The term, however, should properly be confined to a soft and pendulous mucous growth ; the fleshy and malignant polypi being mere varieties of fibrous, myeloid or other sarcomatous tumours, springing from the bones in the nasal fossæ, or from the ethmoidal and sphenoidal cells.

The true **Mucous Nasal Polyp** is a soft, moist, gelatinous tumour, of a greyish-yellow colour when lodged in the nasal fossæ ; but when it descends into the anterior nares, or beyond them, and is exposed to the air, it becomes of a reddish-brown or purple tint, and somewhat shrivelled on the surface. It is usually lobulated, pedunculated, or bottle-shaped ; and not very vascular except at the root, where it is permeated by thin-walled vessels that bleed freely on the slightest touch. In structure it is soft and homogeneous to the naked eye. If cut across and squeezed a large quantity of thin fluid flows from it, and the mass becomes reduced to a small proportion of its original bulk. Mucous polypi are formed by an overgrowth of the mucous and submucous tissue of the nose. They are covered completely by mucous membrane with ciliated epithelium, the cilia of which may be seen in active movement under the microscope after removal. The mucous membrane may or may not contain glands ; occasionally the surface is pitted by the orifices of glands of considerable size. The tissue which forms the bulk of the tumour is composed of delicate bands of connective tissue separated from each other by an abundant mucous fluid. Amongst the fibres are numerous cells either rounded or presenting the stellate form found in true mucous tissue (see Myxoma, Vol. I., p. 1020). The whole mass is abundantly supplied with vessels. Occasionally polypi are found growing from the lower part of the nares, covered with tessellated epithelium. The tumour may grow from any point of the surface of the turbinate and ethmoid bones, and has indeed, though very rarely, been observed to project into the nose from the frontal sinuses and antrum. Polypi most frequently grow from the middle spongy bone, sometimes from the inferior turbinate bone, and in rare cases they are said to have been seen springing from the roof of the nares, but never from the septum. The polypi are usually numerous and of all sizes ; as they increase they commonly extend forwards into the anterior nares, but, when large, they may be seen to reach into the pharynx, hanging down behind the palate.

Symptoms.—The symptoms occasioned by the presence of nasal polypi depend on the interference with respiration and speech, which they occasion. Respiration through the affected nostril is impeded, the patient being unable to blow through it when directed to do so ; and his speech is thick and nasal. There is snuffling with mucous discharge from the nostril : and all these symptoms are worse in damp than in dry weather. On examining the interior of the nose, by opening the nostril widely with the forceps or nasal speculum (Fig. 668), and then directing the patient to blow down, the lower end of the polyp may be distinctly seen, and, if large, will descend to a level with or even beyond the nasal aperture. By the introduction of a probe, the size and extent of the tumour, together with the position of its pedicle, may be readily ascertained. As it grows, it impresses changes on the shape of neighbouring bones, producing expansion and flattening of the nose; and, interfering with the flow of tears down the nasal duct, occasions a watery state of the eyes, which, together with the change of shape in the features, and the peculiar character of voice and respiration, enables the Surgeon at once to recognize the nature of his patient's disease. Polypi occur chiefly in young adults after the age of puberty: but they are not unfrequently met with at later periods of life.

Their **Causes** are very obscure. Most commonly they are referred either to a blow or to a prolonged catarrh. They are more common in women than in men.

Diagnosis.—1. Mucous nasal polypi may be distinguished from *chronic thickening of the mucous membrane covering the spongy bones*, by the absence in the latter of any pedunculated growth around which a probe can be passed, by the florid red character of the thickened membrane, and by the fact that the subjects of this thickening are almost invariably strumous children. 2. In *abscess of the septum*, the history of the case, and the fact of the polyp never being attached to this part of the nose, will establish the diagnosis. 3. *Deviation of the septum* to one side, may at first be a little puzzling; but here the examination of both nostrils, and the discovery of a depression of one side of the septum corresponding to the projection on the other, will reveal the true nature of the case. 4. The *fibrous and malignant tumours* of the nostril will be found to differ sufficiently in consistence and appearance from the ordinary polypi to prevent their being confounded with them in many cases; yet in some instances much care will be required in coming to a definite opinion as to their true nature. 5. In one recorded case a *meningocele* projecting into the nasal cavity was mistaken for a polypus.

Treatment.—The spontaneous separation and expulsion of nasal polypi is of rare occurrence. I have, however, seen one case in which, after the assiduous use of chloride of zinc injections, a very copious discharge of large sloughy polypoid masses took place from one nostril which had been blocked up by them for many months previously, and from which they had even descended into the pharynx.

Nasal polypi may generally be most readily removed by avulsion with forceps; occasionally, but rarely, when they are very large, with a broad base, and especially when they extend into the throat, they require the application of the écraseur. In removing these growths by the *forceps*, instruments of good length but very slender construction should be used—those generally sold are too thick; the interior of the blades should be properly serrated, and have a longitudinal groove, so that the root of the tumour may be tightly grasped. The mucous membrane should first be rendered insensible by the application of a 20 per cent. solution of cocaine by means of a camel's hair pencil. The patient should be made to sit on a rather low chair; and, as there is generally a good deal of bleeding, a towel should be pinned over his clothes, and a basin placed before him to receive the blood and expectorated matters. The Surgeon then, having ascertained by the introduction of a probe, or by means of the blades of the forceps, the situation of the pedicle of the polypus, grasps this firmly and pulls it off with a twisting movement of the hand. He proceeds in this manner, twisting off rather than pulling away polyp after polyp, until the whole of the nostril is cleared, which may be ascertained by examination, and by directing the patient to compress the sound, and to blow through the affected, side of the nose. The bleeding, which is often very free, stops on the application of cold water. It seems to be lessened by the use of cocaine. When the bleeding has ceased, the nose may be dried with cotton-wool, and the stump of the polypus, if it can be seen, may be touched with nitrate of silver or destroyed with the galvanic cautery, to diminish the risk of return. At about the end of a fortnight the patient should be examined again, as it not unfrequently happens that small polypi, which had been prevented from descending into the nares by the presence of the larger ones, now come down and require removal. These procedures must be had recourse to from time to time, until all tendency to fresh formations of this kind has ceased. When the polypus is very large and hangs down into the pharynx the forceps may be guided to its base by the forefinger of the left hand passed from the mouth behind the soft palate.

Polypi may also be removed by the *galvanic écraseur*. To do this the nose is first rendered insensible by cocaine. A speculum is then inserted and a strong light thrown up the nostril. The loop of wire is then passed round the polypus and tightened up on its base. The current is then turned on and the pedicle is rapidly cut through without pain or bleeding. Large polypi passing down into the pharynx may also be removed by the simple wire-écraseur or snare. The loop of wire is passed through the nose and expanded in the throat by the finger passed into the mouth. It is then tightened up and the pedicle cut through. In some instances the polypi attain a great size, producing absorption of the nasal bones, and of the nasal process of the superior maxilla. In such cases it may be necessary, in order to extract them, to slit up the nose, and clip away with forceps the osseous surface from which they spring.

Fibrous Polypus.—Naso-pharyngeal Fibroma.—The term fibrous polypus is applied to a fibroma springing in exceedingly rare cases from the periosteum of the bones entering into the walls of the nasal cavity, but more commonly from the base of the skull, especially from the basilar process of the occipital bone and the under surface of the body of the sphenoid. Fibrous polypus is a disease of early life, seldom commencing before the tenth year or after the twentieth. As the tumour increases in size it gradually fills the upper part of the pharynx, and extends into the posterior part of the nasal cavity. Its surface is lobulated and covered by mucous membrane : it is firm and resisting to the touch. In the earlier stages its form and size can be ascertained only by digital examination from the mouth, the finger being passed up behind the soft palate. In the later stages the tumour may be seen from the nostrils, and may appear below the soft palate, pushing this forward and seriously interfering with deglutition and finally with respiration. These tumours bleed freely, and may even be fatal directly from loss of blood. Microscopic examination shows that they are composed of fibrous tissue, with a varying number of flattened or oat-shaped cells between the fibres. They usually contain large tortuous dilated vessels, which form so prominent a feature in their structure that it has sometimes been suggested to term the growth *fibro-angioma.* When these vessels are opened by ulceration, or in an operation for removal of the growth, they bleed exceedingly freely, being unable to contract or retract owing to the density of the structure in which they lie.

The *prognosis* is extremely unfavourable. If left unrelieved these growths always cause death sooner or later either by hæmorrhage or asphyxia, or in some cases, by erosion of the base of the skull giving rise to brain symptoms.

The *Treatment* consists in their removal whenever this is possible. When the tumour is pedunculated it may be possible to pass the loop of a galvanic écraseur or of a common wire écraseur round the pedicle from the nose. This is, however, seldom practicable. Electrolysis is said to have been successfully used in the destruction of these tumours, but its efficacy is somewhat doubtful. The method generally recognized as being most generally applicable at the present day, is removal by means of Paquelin's red-hot knife; but in order to do this it is necessary to expose the tumour fully, and several plans have been suggested of doing this, of which the following are the most important. When any cutting operation is adopted it is always safer, as great hæmorrhage may be expected, to do a preliminary tracheotomy and to plug the trachea with Trendelenburg's obturator, or to pass a large sponge into the pharynx, otherwise death may be caused by entrance of blood into the lungs.

In 1862 Sir William Lawrence exposed the nasal fossæ for the removal of polypi by carrying an incision round the nose, commencing on one side just internal to the lachrymal sac and terminating at the same point on the other side, passing below between the alæ nasi and the upper lip. The alæ nasi were then separated from the bone and the nasal process of the superior maxilla divided in the incision with cutting-pliers. The septum being then divided, the nose was turned upwards. The nasal cavity is thus very fully exposed and the space obtained may in some cases be sufficient for the removal of a naso-pharyngeal tumour of considerable size.

Ollier recommends a somewhat similar operation, but carries his incision in the opposite direction, commencing at the ala on one side, passing up the side of the nose to the level of the lower margin of the orbit, then across the bridge and down the opposite side, terminating at the ala. The nasal bones and the nasal process of the superior maxilla, so far as it is concerned in the tumour, are then cut through with a fine saw and the nose turned downwards, by which the upper part of the nasal cavity is very fully exposed. In both these methods the nose is replaced after the operation and very little deformity results.

Rouge's operation (p. 571) might in some cases give sufficient access to the nasal cavity.

Manne of Avignon in 1711 attempted to reach these tumours from the mouth by dividing the soft palate. Nélaton extends the operation thus: a transverse incision is first made across the hard palate at the level of the second bicuspid teeth; from the middle of this a second incision is carried backwards, dividing the soft structures of the hard palate and the soft palate. By means of the periosteal elevator and scissors the two flaps thus formed are separated from the bone and turned downwards and outwards, out of the way. The exposed part of the hard palate is then removed with a chisel and mallet, and thus the posterior part of the nasal cavity and the upper part of the pharynx are brought very fully into view. After the removal of the tumour the flaps are united by sutures as in the operation for congenital cleft palate.

Complete removal of the superior maxilla by Syme, Flaubert, and others, has been adopted as a preliminary step to removal of the fibrous tumour when of unusual size. Langenbeck and others have performed partial excisions of the upper jaw, with replacement of the bone after the operation. These proceedings are more fully described in Chapter LVII.

All these operations are more or less difficult and dangerous, and should not be undertaken unless the tumour threatens death from its size or from loss of blood, or shows evident signs of active growth. According to Le Fort, fibrous polypi tend to cease growing with the growth of the patient, and partial destruction of the tumour by cauterization or electrolysis will sometimes succeed in arresting the further progress of the growth.

Malignant Nasal Tumours.—There is a remarkable connexion between the ordinary benign nasal polypus and tumours of a sarcomatous or cancerous character, developing in the vicinity of the nares. I have several times seen in children and young adults tumours of the above-mentioned character developing rapidly in the orbit, the sphenoidal cells, or behind the superior maxilla, after the extraction of perfectly and anatomically benign nasal polypi. The questions to be solved are these :—Are these tumours the result of the irritation of the operation of extraction ? or are they the primary disease lying concealed and undeveloped in the deep cavities of the face, the benign nasal polypi being secondary in reality, though more apparent, and consequent on the irritation set up by the graver and yet latent tumour ? In whatever way future investigators may answer this, the fact remains certain, that a connexion does exist between the two forms of disease.

Tumours of rapid growth, malignant in their course (sometimes called malignant polypus), either epithelioma or sarcoma, occasionally form primarily in the middle of the nasal cavity or about the posterior nares. They grow rapidly, with great expansion of the bones, much discharge, often intense tensive pain, and bleeding, the hæmorrhage being often excessive. They attack children and persons advanced in life. A tumour of this kind may be developed in different situations. Thus, in some cases, it extends into the pharynx behind the soft palate, giving rise to a *naso-pharyngeal tumour ;* in others it has a tendency to protrude through the nasal or lachrymal bones, occasioning obstruction of the nostril, divergence and protrusion of the eyeball, with disturbance of vision, and severe neuralgic pains in the head and face, forming in this case a naso-orbital tumour. If the growth is an epithelioma, the glands under the angle of the jaw soon become enlarged. These growths especially when occurring in young people, speedily prove fatal. Death may occur in various ways, according to the nature of the growth and the direction of its development : by hæmorrhage ; by the implication of the brain ; by asphyxia ; or by constitutional cachexy.

Treatment.—It is seldom that anything very effectual or permanent can be done by operation ; and it should be borne in mind, that some of the malignant growths which project into the nostrils take their origin from the sphenoidal or ethmoidal cells, or even from within the cranium, and that the nasal portion is only the external protrusion, as it were, of a deeply-seated tumour. Should the tumour be slow in its growth, with an absence of secondary, glandular or visceral formations, the Surgeon may endeavour to extirpate it by laying open the side of the face freely, making an incision from the inner angle of the eye down the side of the nose, and then across the cheek, dissecting up this triangular flap, cutting across the superior maxilla above the line of the alveoli, with a narrow-bladed saw and cutting-pliers, and then in a similar way into the orbit beyond and through the nasal bones, and the nasal process of the superior maxilla above the tumour, and thus extirpating the growth. In this operation there is often free bleeding, which may be arrested by the actual cautery, which has the additional advantage of destroying any portions of the tumour left behind in the irregular cavities of this region. In other cases it may be possible to expose the tumour sufficiently by Ollier's or Lawrence's operation. Whenever the upper part of the pharynx is free, it should be plugged before commencing the operation by a sponge passed behind the soft palate, and in the way already described (p. 573). It must not be too large, lest it push the soft palate forwards against the tongue and impede respiration.

Naso-Orbital Tumours commence in the upper part of the nasal fossa or in the ethmoidal cells, perforate the thin inner wall of the orbit and expand into the interior of that cavity, displacing the eye forwards, downwards, or outwards, in two, sometimes in all three of these directions. Vision is often but little, if at all, disturbed. The nostril on the affected side is blocked up by a polypoid growth. But the outline of the superior maxilla and of the hard palate is normal, no projection of the bone, in whole or in part, being perceptible. In fact, the disease and the deformity produced by it occupies a part of the face which is above a horizontal line drawn across the cheek on a level with the upper or orbital border of the superior maxilla. The disease always commences primarily in the nose or in the cavities contiguous to it. The extension into the orbit may not occur for many months. It occurs at all periods of life, from early childhood to commencing old age. At first it may present the ordinary characters of benign nasal polypus. This is removed, recurs rapidly, is again removed, with much hæmorrhage, and then the orbital implication is developed.

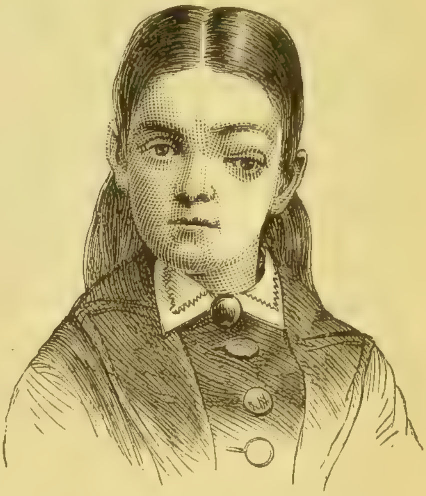


Fig. 671.—Naso-Orbital Tumour.

The *Diagnosis* of the naso-orbital from the naso-pharyngeal tumour may be made by the displacement of the eyeball and absence of all tumour behind the soft palate in the first case; whilst, in the naso-pharyngeal, the orbit is intact, the upper part of the pharynx being occupied by the growth, and the superior maxilla possibly pushed bodily forwards or to one side. In the naso-orbital tumour, the deformity is above the horizontal line of the upper edge of the superior maxilla; in the naso-pharyngeal, it is below this.

The nature of the tumour varies. It is usually a large or small spindle-celled sarcoma, but it may be a squamous epithelioma.

Treatment.—The operation for the removal of naso-orbital tumour may be done as follows. An incision should be made from the root of the nose, directly down along the side and round the ala, so as to open the nasal cavity. The soft parts on the orbital side of this cut are then dissected down into the orbit. One blade of a cutting-pliers being passed into the nose, along the outer border of the nasal bone, the articulation between this and the nasal process of the superior maxilla is cut through. An oblique cut upwards should then be made across the nasal process of the superior maxilla deeply into the orbit, the cut bones widely separated, and the nose turned completely over to the sound side of the face. The tumour at the nasal side of the orbit may now be felt, the eye being held to the outer side and protected with a retractor. The orbital tumour may now be enucleated with the finger and curved scissors. The nostril is then cleared by means of polypus-forceps. The bleeding should be arrested by plugging ; and, after all the morbid growth has been fairly extirpated, the nose should be pushed back and moulded into shape. The soft parts are then brought together with a few points of suture. As in all similar operations, the posterior nares must be plugged to prevent the blood finding its way into the trachea.

Occasionally the disease has extended into the integuments at the inner angle of the eye. Then the operation becomes more complicated. The following cases, operated on by me at University College Hospital, are good illustrations of this operation.

The first case was one of epithelioma, springing deeply from the ethmoidal cells, passing out through the lachrymal bone and the orbital plate of the ethmoid into the orbit, blocking up the right nostril, and extending some way down the cheek, overlying the superior maxilla. It was growing rapidly in a woman 44 years of age, and required extensive removal of the bony structures in the situation from which it sprang.

The next case was one of a woman 64 years of age, in whom a sarcoma developed with great rapidity in the situation of the lachrymal sac, invading the nose and orbit, and destroying the upper and inner part of the superior maxillary bone. The eye was pushed outwards, the eyelids became implicated in their nasal third, and an ulcerated opening formed over the centre of the tumour. Its growth was attended by very severe tensive pain. The operation consisted in dissecting away the diseased part of the integument, including the nasal third of each eyelid, then turning down a flap from the cheek and cutting away with pliers the osseous structures, including the inner part of the floor of the orbit, a considerable portion of the superior maxilla, and part of the nasal bones. In order to repair the gap made by the removal of diseased skin at the side of the nose and by the removal of so large a portion of the eyelids, a flap of integument was dissected off the bridge of the nose and glided over the aperture, to the edges of which and to the eyelids it was fixed by metallic sutures. Good union took place, and the patient made an excellent recovery. The immediate effect of the operation in both these cases was to relieve the patient of the agonizing pain, previously occasioned by the tension in the bones of the face produced by the growth of the tumour.

Busch has described a case, in which the patient, a man aged 78, had a malignant tumour of the size of a fist, occupying the middle of the face. The symptoms at the commencement were those of nasal polypus. In removing it, it was necessary to cut close to the cribriform plate of the ethmoid bone, and as far back as the posterior nares. A flap of skin was transplanted from the forehead, not so much to form a new nose as to cover in the cavity left. The patient was able to leave the hospital in a few weeks.

Columnar Papilloma.—I have once met with this form of growth in the nasal fossæ in a lady past sixty. It sprung from the roof of the nasal cavity, and formed a mass blocking the nostrils and projecting into each orbit laterally. Much relief was obtained for a time by removing the projecting part of the tumour by avulsion with polypus-forceps, but the growth soon returned. A second operation was performed, but death took place on the third day from septic meningitis. The *post-mortem* examination showed that the cribriform plate had been absorbed by the pressure of the growth which had come directly in contact with the dura mater. The cause of death was a small rent in the membrane. The tumour was papillary in structure, and covered with non-ciliated columnar epithelium. Sections of the growth under the microscope closely resembled those of papillary growths from the rectum. The effect produced by the growth on the surrounding parts seemed merely the result of pressure and not of infiltration, consequently the growth may be regarded rather as a papilloma than a columnar epithelioma.

The Frontal Sinuses, though rarely, are occasionally the seat of disease. **Abscess** may form here, with much pain and expansion, and possibly caries of their anterior wall, attended by the local signs of inflammation and by danger of concomitant inflammation of the membranes of the brain. In such circumstances it may be proper for the Surgeon to remove with a trephine the anterior wall of the sinus, and thus give exit to the retained pus. In other instances the anterior wall of the sinus may be necrosed and perforated, the aperture being felt under a puffy tumour of the scalp. Here also the trephine is required. **Distension with serous fluid** has been described as having occurred in some cases. There are a few cases recorded in surgical writings, of **Polypi** springing from these sinuses, and finding their way down into the nose after producing expansion of it and much inconvenience. Here likewise, the propriety of trephining and so extracting the morbid mass would have to be considered.

DISEASES OF THE CHEEKS.

The chief diseases met with in the cheeks are, Nævi (p. 69), Atheromatous Cysts (Vol. I., p. 1000), Subcutaneous Strumous Abscesses (Vol. I., p. 1091), Primary Syphilitic Sores (Vol. I., p. 1120), Tertiary Syphilitic Ulcers (Vol. I., p. 1126), Lupus (Vol. II., p. 3), Epithelioma (Vol. I., p. 1062), and Rodent Ulcer (Vol. II., p. 8). The symptoms and treatment of all these affections have already been described. On the inner surface of the cheek mucous cysts, which can easily be dissected out from the inside, are not uncommon. Epithelioma also is not rare. Malignant tumours affecting the whole thickness of the cheek can seldom be operated on with any advantage.

Salivary Fistula.—One of the most troublesome surgical affections situated in the cheek is *Salivary Fistula*, occurring in consequence of injury, abscess, or operation, by which the parotid gland or duct has been opened, so as to cause a trickling of saliva through the external aperture made into it. The flow of saliva in these cases is always to a great extent and often entirely intermittent, ceasing in the interval between meals and becoming very abundant during mastication.

The *Treatment* is by no means satisfactory, the attempt at union of the opening in the cheek being frustrated by the escape of saliva through it. If the fistula be very small and recent, the electric cautery may be employed with success ; or the external aperture may be touched from time to time with a pointed stick of nitrate of silver. Should these means fail, the fistula having become chronic, operative measures will be required. The closure of an old salivary fistula in the cheek is a very troublesome matter. In these cases the duct appears to be obstructed or partially closed ; and it is useless to attempt to occlude the opening in the cheek until a proper aperture has been made into the mouth ; the escape of a few drops of saliva through the fistulous opening rendering the attempt to close it completely nugatory. The plan of treatment which I have found to answer best is a modification of Desault's. It consists in passing a small hydrocele trochar into the fistula in the cheek, pushing this obliquely forwards and inwards into the mouth, as nearly as possible in the direction of the parotid duct, withdrawing the stilet, and then passing a horse-hair seton through the cannula, so as to bring one end out of the mouth, and the other through the fistula in the cheek. The cannula is then withdrawn, and the seton tied loosely. It should be left in for about three weeks, so as to establish a sinus into the mouth. It is then to be cut and withdrawn, and the sinus in the mouth kept patent by the daily introduction of a probe, by leaving a small piece of gum catheter in it, or, if it show much disposition to close, by the introduction of a laminaria tent. In this way the saliva is diverted from the external opening and made to flow into the mouth. The external aperture in the cheek may now be closed by touching its edges with a pointed stick of nitrate of silver or the galvanic cautery ; or, if large, they may be pared and stitched together.

DISEASES OF THE LIPS.

Congenital Malformation of the Lips is of common occurrence. *Congenital Contraction,* or even complete closure of the orifice of the mouth, has been met with at birth ; such a condition must be remedied, according to circumstances, by the skill of the Surgeon. The opposite condition is also occasionally observed, the opening of the mouth extending on one side too far into the cheek, constituting the condition known as *Macrostoma.* It must be remedied by a plastic operation. By far the most common malformation, however, is the condition termed *Hare-lip,* which will be noticed in detail in the chapter on the Plastic Surgery of the Face and Mouth.

Hypertrophy to a great extent occasionally occurs in either or in both lips. It is especially common in the upper lip in scrofulous children, forming the condition known as "strumous lip." It is often of an œdematous character, being kept up by the irritation of fissures or cracks ; if so, these must be cured, when the size of the lip will gradually diminish. Sometimes, however, it becomes permanent, continuing after the cure of the fissure ; in these circumstances it may be necessary to excise an elliptical portion of the mucous membrane of the lip in a horizontal direction, and then to bring the edges together by means of sutures.

Ulceration is not unfrequently met with on the prolabium, frequently of a simple character, though chronic. It is often dependent on a disordered state of the digestive organs. It will commonly yield to the application of nitrate of silver, to proper constitutional treatment, having for its object the improvement of the digestion, and in very chronic cases to the administration of the preparations of arsenic.

Primary Syphilitic Sores, communicated by kissing, are by no means uncommon on the lips. Their peculiar character has been already described (Vol. I. p. 1120).

Cysts and Erectile Tumours.—The lips may be the seat of cysts and erectile tumours, requiring extirpation by the knife or ligature. In dealing with these, the Surgeon must be guided by the circumstances of the individual case ; but he should, if possible, avoid cutting through the whole thickness of the lip ; and, if compelled to do so, he must act as will be described in speaking of cancer of this region. (See p. 585.) These growths most frequently occur on the lower lip.

Cysts are usually small and transparent, with thin walls, containing a glairy straw-coloured fluid. These should always be dissected out ; mere excision of a portion of the wall being followed by recurrence of the disease.

Nævi of the lip and their treatment have been already fully described (p. 77).

Warty Growths are common on the lip, and are apt after existing some time to become epitheliomatous. Sometimes crusts of epithelium, forming horn-like projections, are developed on the surface. They are best treated by early removal, no local application being of much use, and the danger of their becoming malignant being very considerable.

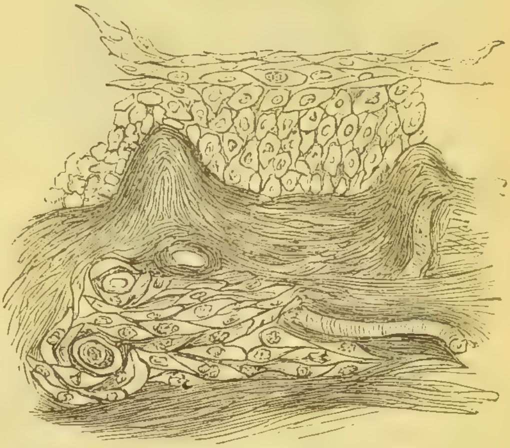


Fig. 672.—Section of an Epithelioma of the Face, showing the Epithelial Cells penetrating into the substance of the true Skin.

Epithelioma.—The structure of epithelioma has been so fully described at p. 1062, Vol. I., that it need not detain us here. The accompanying cut (Fig. 672) represents the microscopic characters usually presented by it in the face and lips.

Epithelioma of the lip commences either as a warty growth, which gradually ulcerates, or as an indurated crack or fissure, the edges of which have a tendency to spread. The submaxillary lymphatic glands tend to become early involved ; and the disease, if unrelieved by operation, will eventually prove fatal by the pain, exhaustion, and constitutional irritation thus induced. Lip-epithelioma almost invariably occurs in men, and in the lower lip ; I have never met with a case affecting the lower lip of a woman. It is met with after the middle period of life. Of twenty consecutive cases in which I have operated, and of which I have notes, thirteen were above sixty, and six between fifty and sixty years of age ; in one case only did the disease occur under thirty. This disease is at first entirely local, often being induced by some irritation, as by a rugged broken tooth, or by smoking a clay-pipe ; and when completely removed it does not, I believe, very commonly recur. At least, of the very many patients that have been operated upon at the University College Hospital, I have known but few to return with a recurrence of the disease; I cannot, therefore, but come to the conclusion that the operation for epithelioma of the lower lip frequently rids the patient permanently of his disease.

When return does take place, it is not always in the cicatrix or in the adjacent glands. I have seen recurrence at the angle of the mouth and inside the cheek of the side opposite to that on which the primary disease had declared itself and been removed, and this not till three or four years after the operation. In these cases the tumour was probably a fresh primary growth.

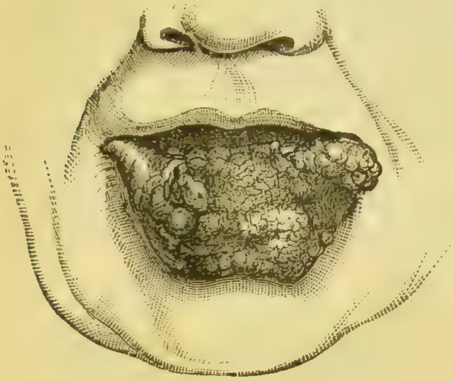


Fig. 673.—Extensive Warty Epithelioma of the Lip.

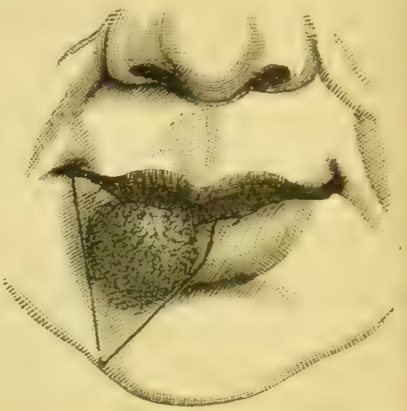


Fig. 674.—Lines of Incision for Removing V-shaped Piece of Lip.

When the glands are enlarged, the advisability of operating will depend upon the extent of the glandular implication. It must be remembered that the internal organs are affected in epithelioma only in exceptional cases, and thus we may hope occasionally to cure the patient permanently even after implication of the lymphatic glands. If merely the submaxillary lymphatic glands are enlarged, they should be fully exposed by a curved incision carried from near the symphysis to the level of the hyoid bone and back to the edge of the sterno-mastoid. The facial artery and vein will probably be divided, and sometimes it is necessary to remove the submaxillary gland which may be implicated by extension from the neighbouring lymphatic glands. A gland must be sought for also between the genio-hyoid muscles. If enlarged glands can be felt beneath the sterno-mastoid, it is better not to operate, as these can seldom be safely removed owing to their adhesion to the carotid sheath. If

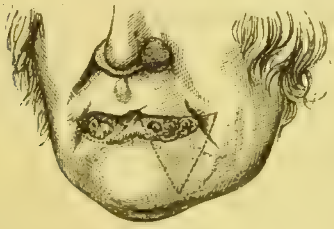


Fig. 675.—Epithelioma of Lower Lip: Lines of Incision.

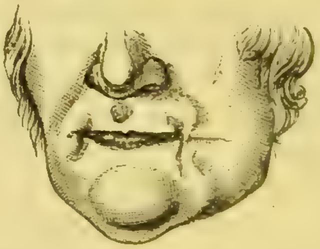


Fig. 676.—Lip after removal of Epithelioma.

the glands are extensively adherent to the skin, then no operation should be attempted.

Operation.—When once the true nature of the disease has been ascertained, the operation should be performed without delay; but before it is done, it is well that any very prominent or broken tooth should be removed, and the tartar cleaned away from the incisors. The operation requires to be somewhat modified, according to the situation and extent of the affection (Fig. 675). If this be tolerably limited, a V-shaped cut, extending widely round it, and carried sufficiently low to include any indurated prolongation in the lymphatics, should be made: the edges of the cut should then be brought together by two hare-lip pins with a twisted suture, as in the case of a simple hare-lip. When the disease occupies a considerable longitudinal extent, but does not dip down very deeply, a slice of the lip should be shaved off, including the whole of the morbid structure; and it is often surprising, in these circumstances, to observe how the tissues of the lip will speedily rise to their natural level, no material deformity being left (Fig. 676). In some cases the disease occupies a square surface, and then it is necessary to excise a portion of the lip; when this is done a considerable gap is left, requiring to be filled by some plastic operation of the kind that will be considered in a subsequent chapter, which may be most conveniently done at the time when the excision is performed. When the disease occurs at the angle of the mouth, it assumes a more intractable character than when affecting the free part of the lip. The same operation—that of free excision—may be applied to it here as in the former case; but with less prospect of success. Should the disease be as extensive as in Fig. 677, the lines of incision must be so planned as completely to surround and to isolate it.

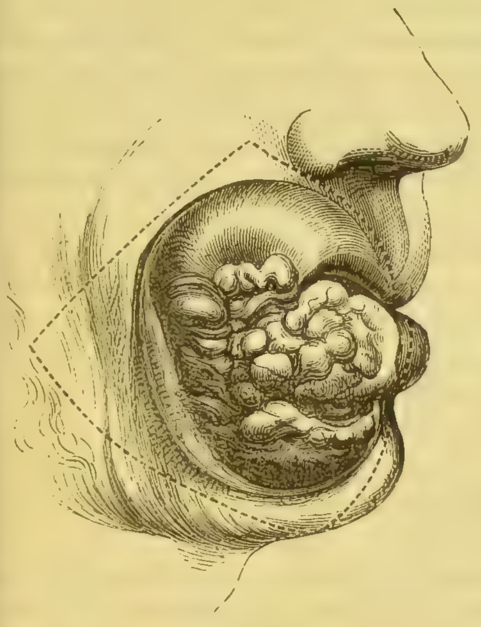


Fig. 677.—Extensive Epithelioma of the Lip Lines of Incision.

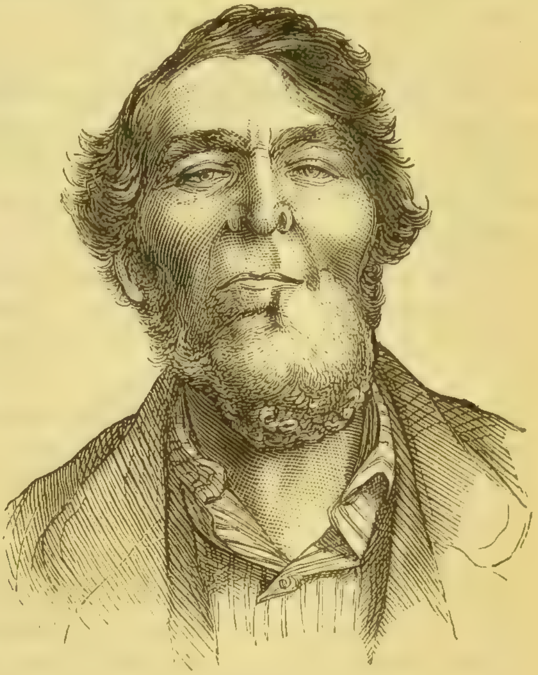


Fig. 678.—Epithelioma of Lower Lip involving Jaw, successfully removed (Heath).

C. Heath has very successfully extended this operation to cases in which the cancer of the lip had invaded the gum, and had involved the lower jaw, by removing a portion of the implicated bone, together with the disease, in the soft parts. Fig. 678 gives a good idea of the cases to which this operation is applicable.

DISEASES OF THE PAROTID GLAND.

Mumps or Parotitis is an acute specific disease, the local manifestation of which is inflammation of the parotid and sometimes of the other salivary glands. It is common in children, though it not unfrequently occurs in adults. It is highly infectious, and frequently epidemic ; and, as in the other acute specific diseases, one attack generally protects the patient from the disease for the rest of his life. It has an incubative period of from two weeks to twenty-two days, but three weeks is the most common time. It commences usually with some febrile disturbance and malaise lasting about twenty-four hours, but this may be wanting. At the end of that time one parotid gland becomes swollen, stiff, and painful ; the swelling continues to increase till about the fourth day, at which time it reaches from the zygoma to the angle of the jaw. The swollen socia parotidis can usually be clearly felt over the masseter and forms a valuable diagnostic sign, distinguishing parotitis from inflammation of the lymphatic glands behind the jaw. When the swelling is at its height, mastication is extremely painful. There is usually elevation of temperature, reaching 102° F. or 103° F. When one gland begins to subside that on the opposite side usually begins to swell and runs the same course ; but occasionally both glands swell simultaneously. Suppuration rarely, if ever, takes place, unless it be in the lymphatic glands of the neighbourhood. As the parotid affection subsides, but sometimes simultaneously with it, inflammation of the testicle in the male, or the breast, labia, or ovary in the female, may take place. These so-called metastases are very rare in children. The orchitis is frequently followed by partial or complete atrophy of the testicle ; but fortunately, as the disease scarcely ever affects both sides, sterility rarely results. Inflammation of the membranes of the brain has been said to have been met with as a complication of mumps.

The *Treatment* of this affection is simple. If it be severe, the application of hot fomentations and the administration of salines, and, when the affection is on the decline, frictions with camphorated oil, will hasten its resolution. The orchitis must be treated with hot fomentations, belladonna and rest.

Parotitis after Injury or Disease of the Abdomen or Pelvis.—Inflammation of the parotid gland, frequently terminating in suppuration, has long been known to be a not uncommon complication of injuries of the abdomen and pelvis, and has usually been regarded as pyæmic. Stephen Paget has, however, shown, by a careful analysis of 101 such cases, that this explanation is not altogether satisfactory. Of the 101 cases, 10 followed injuries or diseases of the urinary tract ; 18 injuries or diseases of the alimentary canal ; 23 injuries or inflammation of the abdominal wall, peritoneum and pelvic cellular tissue ; and 50 injuries, diseases or operations on the generative organs ; 27 of these being operations on the ovary. After a very prolonged search S. Paget succeeded in finding only 13 cases of secondary parotitis arising from operation or injuries of other parts of the body, and in all of these it merely formed a part of general pyæmia. In the histories of the 101 cases the presence of septicæmia or pyæmia is mentioned in only 15, and in 7 only of the fatal cases were secondary centres of suppuration found elsewhere. The inflammation of the parotid commenced at very varying periods after the operation or injury of which it formed a complication. In 78 cases in which the fact was definitely recorded suppuration occurred in 45, the remainder undergoing resolution. As a rule the parotitis was not accompanied by very severe fever, and rigors were very rare. Of the 101, 37 died, 13 from septicæmia or pyæmia and the rest from various causes not directly connected with the parotitis. The treatment in mild cases consists in the external application of belladonna and hot fomentations. If suppuration threatens, it should be anticipated by a free incision into the gland. The explanation of this curious association of parotitis with injuries of the abdomen and pelvis cannot be given in the present state of our knowledge.

Tumours.—Tumours of the parotid gland itself are not so frequent as morbid growths situated upon it or in its vicinity. The tumours met with in this region may be simple or malignant. The simple tumours met with in this region most frequently present a peculiar structure rarely met with in any other part of the body. They consist of mixed cartilage, fibrous tissue, and mucous tissue, to which is often added glandular tissue, imperfectly resembling the structure of a racemose gland. When small they are firm, and somewhat elastic to the feel, smooth or slightly lobulated on the surface, and freely movable on the parts beneath. As they increase in size fluctuating areas become perceptible, often projecting above the rest of the growth. These may be actual cysts containing a glairy fluid formed by mucous softening of the cartilage, or they may be due to the presence of a mass of gelatinous tissue, presenting under the microscope the typical branched cells and mucous intercellular substance of a myxoma. These tumours grow slowly, often taking many years to reach the size of a walnut, but at any time they may take on active growth and reach a large size in a comparatively short time, becoming even as large as a cocoa-nut. The skin covering them becomes thin but not adherent, and not unfrequently a network of veins covers the mass. The simple tumours being distinctly encapsuled, very rarely send any deep prolongations behind the jaw or come into relation with the large blood-vessels. The facial nerve may be adherent to the under surface, but is seldom implicated in such a way as to cause paralysis. Besides the ordinary "parotid tumour" pure cartilaginous growths are not uncommon, and more rarely pure fibromata and myxomata are met with. Cysts, except as secondary formations in solid tumours, are very rare.

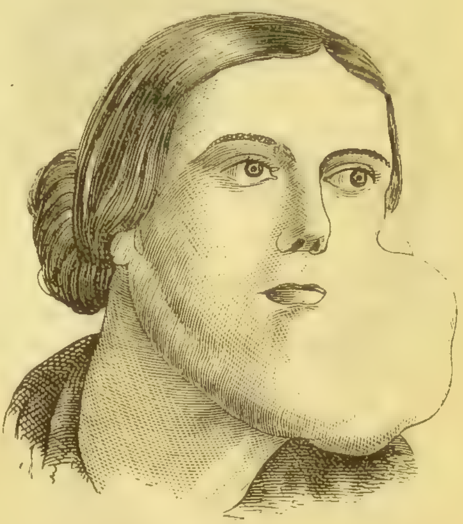


Fig. 679.—Tumour of Parotid, too deeply seated for Removal.

Malignant Tumours of the parotid are of moderately frequent occurrence. They are most commonly soft glandular cancers (encephaloid), but scirrhus has been met with in this situation. They spring from the gland itself and not from the structures superficial to it, as is the case with the simple growths They present the ordinary rapid growth of such tumours; they are from the first fixed and deeply seated, and early implicate the skin.

Spindle-celled and round-celled sarcomata are occasionally met with in this region springing from the bones or fasciæ. They grow rapidly and implicate the surrounding parts. They frequently send prolongations under the ramus of the jaw and occupy the whole of the space between its angle and the mastoid process. They are often firmly bound down beneath the fascia covering the parotid and surround the large vessels at an early period of their growth. As they increase in size they implicate the styloid process and its muscles and come into relation with the internal carotid and the internal jugular vein, and may at last press upon the pharynx and project into the fauces, as was the case with the patient from whom the annexed cut was taken. The facial nerve is, of course, surrounded by the growth and is frequently paralysed, a condition, as before stated, rarely met with as a consequence of a simple tumour. If these tumours are too deeply seated to be removed the patient eventually dies, usually in consequence of disturbance of the cerebral circulation, or of compression of the pharynx and larynx ; or the skin may at last become adherent and give way, profuse hæmorrhage afterwards taking place from the ulcerating tumour.

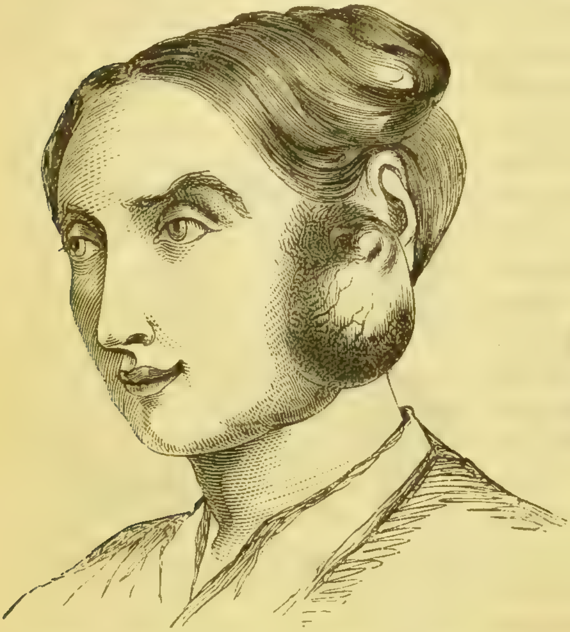


Fig. 680.—Simple Tumour of Parotid.

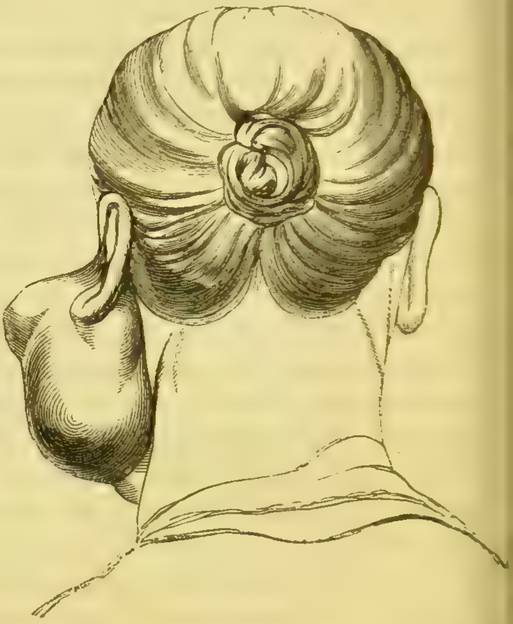


Fig. 681.—Simple Tumour of Parotid : Back View.

Diagnosis.—It is of great importance to effect the diagnosis between the non-malignant and the malignant tumours in the parotid region. In the *simple tumours* there is always mobility ; and, although the attachments may be deep, the skin is not involved to any extent. The outline of the mass is usually well defined and somewhat lobulated. The progress of the growth is very slow, often occupying many years before it attains any considerable bulk, as in the annexed cuts (Figs. 680, 681), representing a tumour of sixteen years' standing which I excised. In the *malignant growths* there is less mobility, and the mass may be solidly fixed ; its outline is ill-defined, the skin soon assumes a reddish purple colour, is brawny, and presents the usual characters indicative of a subjacent malignant growth. When these tumours are *encephaloid*, they grow with considerable rapidity, feel soft and pulpy, and are rounded and ill-defined in their outline, especially under the ear and by the ramus of the jaw. Paralysis of the facial nerve early in the disease is indicative of a deep-seated malignant growth, but the absence of this symptom is no proof that the tumour is simple.

The lymphatic gland, which lies just in front of the neck of the lower jaw and those superficial to the parotid, when chronically enlarged, may often closely resemble a simple parotid tumour. Their mobility is usually less than that of the simple parotid tumour, and they are slightly tender when pressed upon, and it is very seldom that a single gland is affected. It may, however, be impossible to make a certain diagnosis till the tumour is removed.

Treatment.—In the treatment of these tumours, extirpation is necessarily the only course that can be adopted ; and this should certainly not be attempted if the disease be malignant unless at a very early stage ; for, as it would be impossible to remove the deeper attachments of the growth it would speedily return. Even if the tumour be simple, care must be taken that every lobule and prolongation be extirpated ; for, if any be left, however small, it will become the nucleus of a new growth. In removing tumours in this situation, the superficial incisions should be free, so that the whole mass may be fairly exposed. It is not wise to remove integument, however redundant this may appear to be, unless it have undergone incorporation with the tumour, or change of structure ; and even then as little as possible should be taken away. The fibrous or aponeurotic investments of the tumour must be fairly opened, and the edge of the knife must then be directed against it, and the dissection carried on from below upwards, or from behind forwards, so that one division of the blood-vessels supplying it may be sufficient. After the tumour has been well loosened by the division of investing fasciæ and structures (and it is surprising how movable it often becomes after this has been done, though it may previously have appeared to be incorporated somewhat solidly with the subjacent tissues) it should be taken hold of with the hand or a large double hook, and drawn well forwards whilst the deep dissection is being carried on. In prosecuting this, the Surgeon must guard against wounding the temporo-maxillary artery and the facial nerve, which are especially exposed to injury. In some cases the division of these cannot be avoided, as they are incorporated. Hæmorrhage from the divided artery will, however, be easily arrested by ligature. In most instances, however, by keeping the edge of the knife carefully against the tumour, and by drawing it well forward, so as to loosen it in its areolar bed, removal of the morbid mass may be effected without the division of any important vessel or nerve. It is of more consequence to avoid a wound of the portio dura or of the chief branches of the pes anserinus, than even of the temporo-maxillary artery ; as incurable paralysis of the face would result from such an injury. Division of the nerve is best avoided by dissecting out the tumour by incisions parallel to its main trunk and chief branches, and especially by drawing the mass well forward, and directing the knife towards it.

In attempting the removal of a malignant tumour it must be remembered that the styloid process marks the limit beyond which no operative procedure can be safely carried. The vessels superficial to this are easily secured if divided. If, therefore, the tumour extend beyond the styloid process the operation must be abandoned.

If the tumour have been allowed to attain an enormous size, with large lobes lying behind and under the ramus of the jaw, in close relation with the pharynx, the internal carotid, and jugular vein, it will not be prudent to attempt its removal.

Excision of the Parotid Gland itself is occasionally spoken of, but is very rarely done. I believe that in most cases in which it is stated that complete removal of this gland has been accomplished, tumours overlying and compressing it have been mistaken for it. Godlee, in one case in University College Hospital, completely removed the gland for an infiltrating growth. The operation was tedious and difficult, and the facial nerve and carotid artery were necessarily divided. The wound healed well, but the growth returned and ultimately proved fatal. Thompson of Rome has also removed the entire gland in one case.

DISEASES OF THE NECK.

Congenital Fistulæ in the Neck or Branchial Fistulæ are of very rare occurrence. They arise from imperfect closure of one of the branchial clefts, most commonly the lowest (see Fig. 362, Vol. I., p. 1006). The fistula opens on the skin near the sternal origin of the sterno-mastoid. It is lined with mucous membrane and discharges a small quantity of mucous fluid. A fine probe can usually be passed a considerable distance upwards towards the hyoid bone, and, in rare cases, can be made to enter the pharynx. Similar congenital fistulæ have been met with in the middle line of the neck. As they cause no inconvenience they are better left alone as it is impossible to close the whole track, and obliteration of the orifice would probably be followed by the dilatation of the remainder into a cyst.

Cystic Tumours in the Neck.—Six varieties of cysts are met with in the neck ; 1, the congenital multilocular cysts or cystic hygroma ; 2, unilocular serous cysts or hydrocele of the neck ; 3, blood-cysts ; 4, deep atheromatous cysts ; 5, bursal cysts ; and 6, true hydatid cysts.

The **Congenital Multilocular Cysts or Cystic Hygromata** are usually situated in the middle line in the subcutaneous tissue in front of the trachea, where they may attain a good size. Their supposed origin and their structure have been already described (Vol. I., p. 1008). If not too large or too deeply attached they may be removed.

The **Unilocular Serous Cyst or Hydrocele of the Neck** is of somewhat doubtful origin, but it is usually supposed to arise in a space left by the imperfect closure of a branchial cleft. These tumours were accurately described by Maunoir and B. Phillips. They may be congenital, but more commonly appear in children or in early adult life. The cyst is usually situated in the posterior inferior triangle, but has been met with also in front of the sterno-mastoid between that muscle and the jaw, forming a rounded tumour, smooth, tense, and elastic, and filled with a yellow or chocolate-coloured serous fluid. It may attain so large a size as to interfere with deglutition and respiration. The largest I have seen was of the size of an orange. The skin covering this tumour is not discoloured, and is in some cases of natural thickness, in others thin and expanded, so as to give a bladder-like appearance to the growth.

The *Treatment* of this tumour consists in tapping, when complete collapse of the cyst takes place : it however soon fills again. A permanent cure may be effected by injection with iodine, or by opening the cyst, sponging it out with chloride of zinc (gr. xl. to ℥j), attaching the wall to the skin by sutures and inserting a drainage-tube. It is usually impossible to dissect the cyst out owing to the depth of its attachments and the thinness of its wall.

3. **Blood-Cyst or Hæmatocele of the Neck.**—This may be merely one of the cysts just described into which hæmorrhage has accidentally taken place. The true blood-cysts, however, are much more serious; when punctured pure blood escapes, sometimes almost arterial in tint, and even if the cyst be emptied it speedily fills again. They have been met with in close connection with the great vessels of the neck. Their origin is not certainly known, but some have supposed them to originate from a cyst-like dilatation of one of the large veins of the neck. In others no communication has been found with any large vessels, but the lining membrane was highly vascular. The *Treatment* consists in puncturing the cyst with a fine trochar and injecting iodine or perchloride of iron. If the cyst could be partially emptied by pressure, showing communication with a large vein, this would evidently not be justifiable. Gay successfully dissected one out, which lay in close contact with the carotid sheath.

4. **Deep Atheromatous Cysts** are very rare. They are of congenital origin, and arise from inclusion of a fold of skin during closure of the branchial clefts (Vol. I., p. 1000). Their most common situations are below the jaw, in the middle line pushing upwards beneath the tongue and along the anterior border of the sterno-mastoid. The only *Treatment* consists in dissecting them out. The operation may be very difficult, owing to the relations of the cyst-wall to the large vessels and other important parts.

5. The **Bursal Cysts** occur in the middle line about the hyoid bone and the front of the larynx. They have already been described with disease of bursæ (p. 497).

6. **True Hydatid Cysts** sometimes form in the neck. A woman was under my care in the Hospital for a hydatid tumour of the liver, which I tapped; seven years afterwards she presented herself with a thin-walled elastic semi-transparent tumour in the posterior inferior triangle of the neck, about the size of an orange. This I tapped, and found to contain clear serous fluid, with the remains of echinococci. In another case, that of a lad aged about 18, otherwise healthy, I removed a hydatid tumour as large as a shaddock from the nape of the neck, where it was deeply seated under the trapezius, growing apparently from the substance of the complexus or splenius capitis muscles, and lying close upon the cervical spine and the occipital bone.

Solid Tumours of the Neck.—Fatty tumours and the various forms of sarcoma, may occur in the subcutaneous tissue and fascia of the neck as elsewhere, but they present nothing special. The neck is the favourite seat of lymphadenoma, the tumours in this situation often reaching an enormous size, so as to endanger life by their pressure. In the submaxillary region, tumours are occasionally met with similar in character to the parotid tumour already described. The submaxillary gland itself is rarely the seat of disease.

Tumours in these situations may occasionally attain a considerable size, and if beneath the fascia, may extend deeply. In some cases when the integuments and superficial structures covering the growth are divided, it may be isolated with sufficient facility, its fixity being in a great measure due to its being bound down by the investing fascia rather than to its having contracted deep adhesions. Occasionally, though rarely, a slowly-growing simple tumour develops deeply in the anterior triangle of the neck, lying between the sterno-mastoid, the trachea, and the pharynx, possibly even under the carotid sheath, with the artery pushed on one side, or even running over the anterior convexity of the growth. In some cases, the question of removal requires to be approached with the utmost caution. If the tumour be movable above the vessels, it may generally be taken out; if it lie below the sheath, even though not fixed to the spine, its extirpation is not practicable. Before determining upon the removal of a tumour situated in one of the triangles of the neck, it is indeed always very necessary that a diagnosis of its nature be effected, and that some opinion be formed of the probable extent of its deep attachments.

The first point to ascertain is whether it be simple or malignant. If simple, it will usually have been many years in growing; it will be hard but not stony, lobulated or somewhat square-shaped; the patient's general health being good. It will generally be found to be movable, though not perhaps to any great extent, and will present no sign of incorporation with neighbouring structures. If it be superficial, the fibres of the platysma will not appear to spread over it, and the sterno-mastoid muscle may be traced to one side of or below it. In such circumstances, removal of the tumour may be undertaken with every prospect of success. But if the tumour be of stony hardness, have implicated the skin, and be immovable, the whole head being moved on any attempt at drawing it aside, if it be ill-defined under the jaw and ear, or rapidly growing, soft and pulpy to the feel, deeply-seated under the angle of the jaw, evidently below the platysma and deep fascia of the neck, and possibly beneath the sterno-mastoid, then no attempt at extirpation should be undertaken, as the mass could either not be removed with safety, or, if it were by any possibility extirpated, the already existing contamination of the neighbouring parts would certainly lead to a speedy recurrence of the disease.

In removing *submaxillary tumours*, a free superficial incision nearly parallel to the margin of the lower jaw, but below this, will usually allow ready extirpation of the mass. In these operations the facial artery is generally sufficiently under cover of the bone to escape injury, but there may be, and usually is, free venous hæmorrhage.

Congenital Tumour or Induration of the Sterno-mastoid.—These terms are applied to a diffuse thickening and induration of the sterno-mastoid, affecting especially its lower and sternal part, occasionally met with in infants. It is observed either at birth or shortly after. It disappears after a few weeks or months without special treatment. Its nature is somewhat uncertain; it has been attributed to injury during birth, especially in cases of breech-presentation; Bryant considers it inflammatory; Holmes is inclined to regard it as a congenital hypertrophy; and by others, it has been referred to syphilis. In a case recorded by F. Taylor, in which the swelling was examined after death, it was found to be due to a new growth of fibrous tissue between the bundles of muscular fibres. The child was syphilitic, and the case was also one of breech-presentation at birth.

Diffuse Cellulitis of the Neck. Ludwig's Angina has been described in Vol. I. at p. 957.

DISEASES OF THE THYROID GLAND.

The thyroid gland is subject to various simple chronic enlargements, which commonly go by the name of *Bronchocele* or *Goître.* The gland is composed of closed vesicles, lined by a single layer of cubical epithelium, containing a clear albuminous fluid. The vesicles are held together by areolar tissue, supporting numerous vessels of considerable size. Virchow has shown that all forms of bronchocele commence by a true hypertrophy of the gland-substance, but as the enlargement progresses, one or other of the constituent elements of the gland may increase out of proportion to the others. If all the constituents continue to increase equally, the *Simple Bronchocele* results; if the contents of the vesicles accumulate, unduly distending the cavities, the disease assumes the form known as *Cystic Bronchocele.* Very commonly there is a great increase of the fibrous tissue, forming the *Fibrous Bronchocele,* and occasionally great dilatation of the vessels takes place with simple hypertrophy of the remaining structures of the gland, forming the *Pulsating Bronchocele.* Secondary changes also may modify the structure of the tumour. Of these the most common is a substitution of a gelatinous colloid material for the albuminous fluid normally found in the vesicles of the gland. Calcification also is common both in the walls of the cysts in cystic bronchocele, and in the masses of fibrous tissue in the fibrous goître.

The **Causes** of bronchocele have been much discussed, both professionally and popularly. The most generally received belief is, that the disease is directly occasioned by some impurity in, or peculiarity of, the water that the patients drink; and it has been supposed that water coming through chalk or limestone is particularly apt to occasion bronchocele in this country, and that water resulting from melted snow is its occasioning cause in Switzerland. But these ideas are groundless. Hard water is drunk largely in this country in districts where no bronchocele occurs, and snow-water is never used in Switzerland; spring-water of the purest kind only being drunk. It would appear that air and locality have much more to do with the occurrence of bronchocele than water. In mountainous countries the disease occurs almost entirely amongst the inhabitants of valleys, where the air is moist and stagnant; the inhabitants, especially, of valleys that run north and south, into which the sun does not penetrate readily, or for many hours in the day, which are always in the shade of neighbouring and overhanging mountains, are especially prone to it. This is well known to be the case in Switzerland, where the disease is endemic; so also in large towns, it occurs chiefly amongst the poor who live in cellars and kitchens, or damp, ill-ventilated streets and courts. When it is met with in the richer classes, it is found mainly amongst children and young people shut up in school-rooms or devoted to a sedentary and indoor life. It is rarely, if ever, met with amongst those who lead open-air and active lives. Bad food and low living no doubt conduce to it. The tendency is probably hereditary in some cases; when associated with idiocy, constituting that wretched condition "cretinism," it undoubtedly is so. Every race of men is liable to bronchocele, and it occurs in all latitudes, from the Arctic region to the tropics. Thus Franklin found bronchocele amongst the inhabitants of the polar regions, and Mungo Park amongst those of the interior of Africa. In this country it is most common in Derbyshire, and has consequently received the name of "*Derbyshire neck.*" It is most frequent amongst women.

SYMPTOMS AND VARIETIES.—**Simple Hypertrophy** or **Parenchymatous Goitre.**—In this form the thyroid gland is simply increased in size without any marked change in structure. It may attain a considerable bulk, forming a smooth rounded tumour, maintaining more or less accurately the form of the normal gland, though frequently the enlargement on one side is greater than on the other. It is soft and elastic to the feel, and moves up and down with the trachea during deglutition. In the majority of instances in England, the tumour is of but very moderate size, commencing at first as a mere fulness and uniform rounded enlargement of the isthmus, until perhaps, by the pressure of the growth confined between the sterno-mastoid muscle and under the deep fascia of the neck, the voice becomes croaking and harsh, and respiration is seriously affected, especially on exertion, and occasionally there may be some interference with deglutition. It is seldom that the bronchocele distorts the structures of the neck to one side; but this may happen. Thus I have seen the larynx and trachea pushed completely over to the left, forming a long convexity in that direction, whilst the carotid sheath on the right side was thrust behind the sterno-mastoid muscle.

When the tumour reaches any considerable size it presses on the veins of the neck and thus causes interference with the cerebral circulation; the face becomes turgid, the superficial veins are distended and the patient may suffer from headache, vertigo, or drowsiness.

There is a remarkable connection between tumours of the thyroid gland of this kind, and a general anæmic condition of the system. In London nothing is more common than to find a certain degree of bronchocele in pale and bloodless women and girls; indeed, so frequent is the coincidence that it is impossible not to regard it in the light of cause and effect.

Fibrous Bronchocele.—This form commences as simple hypertrophy, but as the tumour increases in size it loses its soft elastic feel and becomes dense and indurated; at the same time its form often changes, becoming more irregular and lobulated. The pressure-effects of the fibrous bronchocele are more severe than those of the simple form, owing to the greater density of its structure. Respiration may be greatly impeded, at first only during exertion, but, when the growth reaches a considerable size, during rest also. Occasionally the tumour may extend below under the sternum, and the pressure-signs then become more serious. In other cases the recurrent laryngeal nerve may be compressed causing spasm and, subsequently in some cases, paralysis of the abductors of the vocal cords. Deglutition is seldom seriously interfered with.

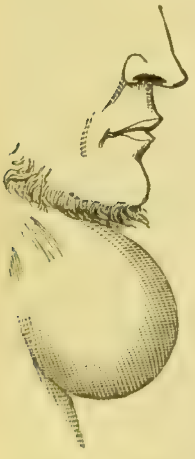


Fig. 682.—Cyst of Thyroid, containing clear Serous Fluid.

Cystic Bronchocele is due to the development of cysts in the substance of the enlarged gland. These cysts may be single or multiple. When single or of large size, as in Fig. 682, they usually contain clear serous fluid. When multiple, they are filled with colloid substance, or with a fluid that presents the ordinary characters of altered blood, being dark, grumous, or like coffee-grounds. Cauliflower-like excrescences projecting into the interior are sometimes met with.

Pulsating Bronchocele is occasionally met with. The pulsation which is excentric and distensile, is synchronous with the heart's action, and evidently due to the vascular character of the tumour itself. This form of bronchocele is sometimes conjoined with the cystic. When it is confined to one lobe only, care must be taken not to confound the beatings with those of carotid aneurism; a mistake which I have known to occur. The diagnosis of the two affections has been adverted to at p. 173, Vol. II.

Treatment.—The treatment of bronchocele must vary according to the size and character of the tumour, and the constitutional condition associated with it. When small, and associated with anæmia, and of comparatively recent formation, it is best treated by improving the general condition of the patient. This may be done in various ways: by the administration of good food; by change of air from a low and damp to an elevated and dry and healthy situation. The change to a higher, and drier, and more airy locality has been much insisted on by those who have studied the disease in those valleys of Switzerland in which it is endemic; and establishments have been erected several thousand feet above the level of the sea, on mountain-tops, with the view of curing patients thus affected. Guggenbühl has been particularly successful in these endeavours. In towns, the patient, if living on the basement floor, should be moved to the upper storey, if possible, and should be encouraged in habits of outdoor rather than of sedentary or indoor occupations. Besides these hygienic measures, which are of the first importance, the disease may be treated medically by the administration of iron, especially the iodide, internally, and the external application of iodine or of iodide of lead ointment. Indeed, in the soft bronchocele occurring in anæmic females iron is of the utmost service, and acts almost as a specific.

In bronchoceles of large size, and unconnected with anæmia, the chief reliance is to be placed on the free and continuous use of *iodine* internally as well as externally. The iodide of potassium is the best form in which to give the iodine internally. The quantity of this medicine should be gradually increased, until from 20 to 30 grains are given three times a day either alone, in milk, or in combination with some preparation of iron; the iodide is probably the best. But iron is very necessary in all the anæmic forms of the disease. Iodide of lead and compound iodine ointment may be used with advantage. It has been recommended by Mouat that the biniodide of mercury ointment (16 grs. to the ounce) should be well rubbed in for several days; and then, the tumour being covered with it, the patient should be exposed to the strong heat of a mid-day summer sun. This method of treatment, which is said to have been extremely successful in India, is seldom practicable in this country. In some instances *pressure* has been of use, especially in conjunction with the iodide-inunctions; though it is not so easy to apply this means, and no considerable degree of it can be borne, on account of the increased difficulty of respiration that is thus occasioned. In fact, the compression exercised by the tumour alone is in some cases so considerable that it has been suggested to divide the sterno-mastoid muscles subcutaneously in order to relieve the trachea from constriction. This operation, however, could be productive of but little if any benefit, as the tumour is bound down more by the deep cervical fascia than by the muscles. When bronchocele is very large, and very chronic, its absorption cannot, I think, be expected to be brought about by these or any other means; and the question then arises as to the propriety of having recourse to operative interference. The introduction of a **seton** across the tumour is occasionally attended with beneficial results. This operation, however, is not unaccompanied by danger ; a patient in the neighbourhood of London, on whom it was being performed some years ago, lost his life by the entrance of air into a vein which was accidentally punctured at the root of the neck. Moreover, it may set up diffuse inflammation in the diseased gland, and at the best is very uncertain in its results.

Injection of Tincture of Iodine into the substance of the gland is recommended by Billroth in cases of simple hypertrophy. In fibrous bronchoceles he does not advise it, as they are often permeated by very large blood-vessels. The iodine is injected by means of a hypodermic syringe, about ten minims being thrown in at a time. The operation may be repeated twice or three times a week, according to the effect. In performing the operation care must be taken that the point of the needle is actually in the substance of the gland, and that a superficial vein be not wounded, and that no air is injected. The fluid must be injected slowly. With all these precautions, however, this mode of treatment is not free from danger from entrance of air, embolism, or acute inflammation and suppuration in the gland.

Injection of Perchloride of Iron by means of the syringe figured at p. 71, Vol. II., might be of service in some cases of very vascular and pulsating bronchocele ; but it is not without the special danger of forming a plug in the circulation, and rapidly fatal embolism may follow its use. A fatal accident of this kind has in fact been recorded. In one instance of pulsating bronchocele in which I employed it, although much local inflammation and deep-seated suppuration were induced by it, the patient was in the end materially benefited.

Ligature of the Thyroid Arteries has been practised by some Surgeons, with, it is stated, a certain degree of success. The difficulties and danger of the operation, the uncertainty of its results, and the readiness with which the arterial supply would be forwarded to the tumour from other sources, have caused it to be but little resorted to by Surgeons of the present day. In one case of pulsating bronchocele in which I had recourse to this treatment, no benefit resulted from it.

Excision of the Thyroid Body.—Cases occasionally occur in which, from pressure on the trachea, œsophagus, and jugular vein, the dyspnœa becomes so severe, and the dysphagia and vertigo so serious, that there is no escape from death except by partial or complete removal of the tumour. Complete removal of the thyroid body was carried out by Roux, Warren, Greene, and others, in a few exceptional cases between 1820 and 1870, but the results were not encouraging, some of the patients having died on the table from hæmorrhage, and others shortly after the operation from septicæmia and other causes. Since 1870 the operation has been very frequently performed by P. H. Watson, Kocher, Billroth, and many others, with a large amount of success, so far as the immediate result is concerned. In 1883, however, Reverdin and Kocher observed that in a considerable number of cases the complete removal of the thyroid gland was followed by a peculiar train of symptoms terminating in many cases in death. At the time Kocher published his observations he had partially or wholly excised the thyroid body in 101 cases—of these he was able to trace the after-conditions in 28 cases of partial, and in 18 cases of total extirpation of this organ. In none of the cases of partial excision was any deterioration of general health noticeable. Of the 18 cases of total extirpation, in two only was there no change for the worse with regard to the general health, and it was most remarkable, that in one of these cases a vicarious hypertrophy of a small accessory thyroid body had taken place, whilst in the other a return of the goître had made its appearance.

In all the remaining 16 cases of total extirpation, more or less marked signs of derangement of general health were manifest. This derangement was of a progressive character, being more noticeable in the oldest, least so in the more recent cases that had been operated on. Professor Kocher describes the symptoms that manifest themselves as occurring in the following order. Some time after leaving the hospital a sense of fatigue, lassitude, and weariness was experienced in the limbs, with dragging pains in the arms and legs. A sensation of coldness soon was superadded, especially in the hands and feet, which parts in the winter became bluish-red and cold, chilblains making their appearance. The mental activity decreased, thought and speech became slow. The movements generally were sluggish, but there was no impairment of the mental powers. Swelling of the body, but more especially of the face, now began to take place. The eyelids became thickened and somewhat transparent, and the expression of the countenance idiotic. The hands, face, and abdomen swelled ; the skin lost its elasticity and became dry ; the hair fell off, and in more developed cases anæmia occurred. In young subjects the growth of the body was retarded in a very marked manner. In some cases dysphagia, headache, and giddiness were met with.

These symptoms, to which Kocher gave the name of "cachexia strumipriva," it will be observed, are identical with those of the disease first described by Sir William Gull as a "cretinoid condition," and subsequently more fully by Miller Ord, under the name of "myxœdema." Ord showed that this condition is invariably associated with more or less complete atrophy of the thyroid body. Beyond this, the characteristic *post-mortem* appearance in the disease is the presence of large quantities of mucin in every tissue in the body. In 1885 Victor Horsley showed that by removing the thyroid gland in monkeys an identical condition was invariably produced. These observations clearly prove that the thyroid gland plays some most important part in the animal economy, although its exact functions are not as yet accurately determined. They show, moreover, that complete removal of the thyroid body is not a justifiable proceeding, and that whatever mode of operating be adopted some portion of the gland substance should be left behind.

The operations which may be undertaken are partial excision of the gland, excision of the isthmus, and scooping out a portion of the substance of the tumour.

Excision of Half the Thyroid Body is best done by an incision in the middle line, from the upper border of the tumour to the sternal notch. From the upper extremity of this a lateral incision may be carried outwards and upwards along the upper border of the tumour, as far as may be necessary. The platysma and deep cervical fascia are then divided to the extent of the wound, and the sterno-hyoid and thyroid muscles and omo-hyoid muscles drawn on one side or divided if necessary. Large dilated veins are usually found on the surface of the tumour, which must be carefully divided between double ligatures. P. H. Watson recommends that the delicate fascial investment of the thyroid body, which is continuous with the sheaths of the thyroid vessels, should be left intact. The next step in the operation is to find the thyroid arteries as they enter the gland. This must be done by carefully tearing through the areolar tissue surrounding the thyroid body with forceps and a blunt instrument, such as a director. The vessels, being found, must be securely ligatured within their sheaths, by passing an aneurism needle round them and tying them *en masse.* Double ligatures should be used, and the vessels divided between them. The vein may safely be included with the artery. It is of the first importance that the vessels be tied with their sheaths, for, as Watson observes, their coats are so thin that they are very likely to be torn by any attempt to isolate them cleanly. In ligaturing the inferior thyroid, special care must be taken not to include or injure the recurrent laryngeal nerve. After the supplying vessels have been thus ligatured and divided, the tumour may be carefully raised towards the middle line until the isthmus is reached. This must be carefully divided in the middle line, all bleeding vessels being secured as they are cut, or a Paquelin's cautery may be used if the tumour is very vascular. The dangers during the operation are hæmorrhage, entrance of air into the dilated veins, wound of the internal jugular vein, to which the tumour is sometimes adherent, and injury to the recurrent laryngeal nerve. These can only be avoided by careful dissection, and by the application of double ligatures to every vessel before it is divided. If the tumour be very large, a part may be removed from the opposite side, but some portion of the gland should always be left.

Excision of the Isthmus of the thyroid has been recommended by Tillaux as a means of cure in certain cases of bronchocele, the effect of the operation being to lead to atrophy of the enlarged lateral lobes of the thyroid. Tillaux in Paris, and Sydney Jones in this country, have practised the operations successfully in several cases. The operation consists in exposing the isthmus by a median incision, passing a ligature round it at each end, tying them tightly, and then excising the intervening portion. S. Jones advises that the wound should be well drained. The result appears to have been very satisfactory.

Scooping out a portion of the Thyroid Body by means of a large sharp spoon has lately been practised with success by Sir Joseph Lister and others. An incision is made near the edge of the sterno-mastoid, avoiding any large veins that may be visible. On exposing the tumour an opening is made into it by means of Paquelin's cautery. The sharp spoon is then introduced, and a considerable portion of the substance of the tumour rapidly scooped out. The hæmorrhage, which is usually very free, may be restrained by pressure, and, if necessary, the cavity must be immediately plugged with some efficient antiseptic material. The plugs may be removed in a few days, and a drainage-tube inserted. The strictest attention to the prevention of decomposition is necessary. In some cases of fibrous goître isolated tumours are present in the enlarged gland, which may be enucleated with but little difficulty.

In all operations on the thyroid body the strictest antiseptic precautions must be taken, otherwise death from septicæmia, or from septic suppuration extending into the mediastinum, is very likely to occur.

Treatment of Cystic Bronchocele.—When the tumour is chiefly cystic, the fluid contents may be drawn off by tapping, and an endeavour may be made to close the cysts by inducing inflammation in them by the injection of tincture of iodine. The fluid that flows from the cyst is often darkly stained with blood, and occasionally pure blood may escape in considerable quantities from the puncture. Morell Mackenzie advises the injection of the cyst with perchloride of iron to check the flow of blood that often takes place from the cyst wall. He recommends that the cyst be tapped with a trochar and cannula; after the fluid has escaped a solution of perchloride of iron (ʒij. to ℥j. of water) is injected; the cannula is then plugged and left in till suppuration is established, after which it may be withdrawn and a drainage-tube substituted.

Incision of the cyst, and attaching its walls to the skin, is another mode of treatment which has been sometimes adopted. The only danger attending this is the free hæmorrhage that may take place from the vascular cyst wall. This must be arrested by plugging the cavity with some antiseptic material, which should be prepared in readiness before the operation is commenced. If the discharges decompose, the patient runs considerable risk of pyæmia, septicæmia, or diffuse suppuration in the neck.

Acute Bronchocele is a very different disease from the chronic forms. It is of rare occurrence, but has been met with both sporadically and epidemically, and in young subjects. In this form of the affection the thyroid gland undergoes rapid enlargement, attaining to the size of the fist or larger in the course of a few days or weeks. Both lobes and the isthmus become affected. Owing to the rapid enlargement of the thyroid body, the fascia of the neck covering it does not stretch with sufficient rapidity; and the consequence is that the subjacent parts, as the trachea, become compressed, so that intense dyspnœa sets in, and death from asphyxia may result in the course of a few days or weeks. It is difficult in these cases to know how to save the patient; for tracheotomy by the ordinary methods may be impracticable, owing to the manner in which the tumour dips down behind the sternum. In such cases, tapping the tumour in different places, and the division of the fascia of the neck covering it, may give relief, and afford time for the action of remedies. If this fails and death is imminent from asphyxia, two courses only are open to the Surgeon: either the isthmus must be divided accurately in the middle line, Paquelin's red-hot knife being used to limit the hæmorrhage, or the larynx may be opened, the cricoid cartilage being divided and a long cannula or a catheter be passed downwards past the obstruction. The latter method has been successfully adopted by König, who has invented a special cannula for such cases. In his case the tube had to be passed nearly five inches downwards before air entered freely through it.

Exophthalmic Goître.—Graves's Disease.—In practice we not uncommonly observe a triple clinical combination, of anæmia, exophthalmos, and bronchocele; and the connection of these has been commented on by Graves, Basedow, Sichel, White Cooper, Aran, Begbie, and numerous other practitioners. Exophthalmic goître is almost exclusively met with in women, usually in young adult life. It commences usually with anæmia and some menstrual disturbance. These are accompanied by palpitation and irregular action of the heart; often with considerable breathlessness. Enlargement of the thyroid gland soon follows, assuming the form of the pulsating bronchocele. At the same time that this gland enlarges, protrusion of the eyeballs becomes a marked symptom. In extreme cases the exophthalmos may be so great that the lids cannot properly cover the eyeballs, and inflammation of the conjunctiva and cornea may result; except from this cause, however, there is no affection of vision. The disease may steadily increase and death take place from some intercurrent disease or general wasting, more rarely from pressure of the enlarged gland on the trachea. In other cases the symptoms may gradually subside and the patient recover. The exact nature of the disease is unknown. Shingleton Smith has described changes in the cervical sympathetic ganglia, which he is inclined to regard as the cause of the disease. The ganglia showed an increase of connective tissue with atrophy of the ganglionic cells. The *treatment* consists in rest, the administration of iron and aloetic purgatives.

Acute Inflammation of the Thyroid Body.—Thyroiditis.—This is an uncommon affection, and is rarely, if ever, met with in a gland not already enlarged. It may arise sometimes without apparent cause, and is then attributed to exposure to cold, but more commonly it is the result of injury or a part of general pyæmic infection. It is characterized by acute febrile disturbance, sometimes commencing with a rigor. The gland becomes hot, tender, and rapidly swells, sometimes to such an extent as to threaten death from suffocation. The inflammation may subside in a few days or may terminate in suppuration, which is indicated by increasing redness and the presence of fluctuation. The *treatment* consists in the application of leeches and hot fomentations. If suppuration is suspected, the pus must be sought for with an aspirator. If it is found, an incision must be made and a drainage-tube inserted. To avoid hæmorrhage, the gland substance may be divided with Paquelin's cautery.

Malignant Tumours of the Thyroid Body.—Kauffman, in 1879, published a paper in which he recorded 30 cases, partly his own and partly collected, of malignant tumour of the thyroid body; of these 23 were carcinoma, and 7 sarcoma. In every case the malignant tumour originated in a gland already affected by chronic bronchocele. The tumours usually affected one lobe only, but in a few cases the whole gland was implicated. The cancerous tumours were characterized by rapid growth, infiltration of neighbouring structures, and early infection of the lymphatic glands and internal organs. In six cases, secondary tumours formed in the bones. The tumour was in all cases soft in consistence, and microscopic examination showed that the morbid growth commenced by proliferation of the normal cells of the gland, the new cells first filling the spaces and then burrowing into the surrounding parts in columns. The cells were in most cases polygonal, but in one the spaces were lined with cylindrical epithelium.

The sarcomata were round-celled, spindle-celled, and mixed. In one case the growth perforated the trachea, and in all secondary tumours appeared, in three cases in the lymphatic glands.

A special form of malignant tumour of the thyroid body has been met with in a few recorded cases in which the secondary tumours closely resembled the normal thyroid body in structure. These were first described by Cohnheim, and cases have been recorded by Morris, Warrington Haward, and Neumann. In all these the lymphatic glands were affected, and pulsating growths appeared in the bones.

The thyroid body is also sometimes implicated by malignant sarcomata springing from the structures in its neighbourhood, and by epithelioma of the œsophagus or larynx. It is very rarely the seat of secondary malignant growths.

CHAPTER LVI.

DISEASES OF THE JAWS AND THEIR APPENDAGES.

DISEASES OF THE GUMS AND ALVEOLAR PROCESSES.

Abscess of the Gums, Alveolar Abscess or Gumboil is of very frequent occurrence, from the irritation of decayed teeth. The common gumboil forms at the edge of the gum and is quite superficial; it is at once relieved by puncturing it with a lancet. A more troublesome form of alveolar abscess is that which develops in connection with the fang of a tooth, usually carious but occasionally apparently healthy. The pus forms at the extremity of the fang, the alveolus being absorbed around it, so that a small abscess-cavity is hollowed out deep in the bone. The pus may find its way out along the tooth, pointing at the margin of the gum, but not unfrequently, especially in the molar or bicuspid teeth, it perforates the compact tissue of the jaw-bone and forms an abscess deeply seated below the reflexion of the mucous membrane from the gum to the lip or cheek. This is accompanied by considerable swelling of the face and severe pain. The nature of the swelling is recognized by its being firmly fixed to the jaw. By a free and early incision and extraction of the diseased tooth the pus may be let out into the mouth and immediate relief obtained, but not uncommonly in the lower jaw the abscess opens externally near the angle, and a troublesome sinus may be left which refuses to heal until the affected tooth is removed. In the upper jaw the pus may burst into the antrum or may burrow beneath the palate, forming an abscess in the roof of the mouth which occasionally leads to necrosis of a portion of the bone. To prevent this such abscesses should be opened early and the diseased tooth immediately extracted.

Spongy Gums, sometimes accompanied by ulceration, may occur as the result of scurvy, or from the administration of mercury. If the condition be due to scurvy, it is quickly relieved by attention to diet, fresh fruit and vegetables being freely supplied. The mouth may be washed at the same time with an alum-gargle. Such cases are not uncommon among the female poor of large cities whose food consists chiefly of bread and tea. In mercurial salivation a strong alum-gargle will be found the best remedy.

In scrofulous ill-fed children a *spongy condition of the gums with ulceration* and fœtor of the breath is sometimes met with. The ulcers are covered on the surface with a grey slough. The cause of the condition is often obscure. It must be treated by tonics, cod-liver-oil and iron, and by chlorate of potash, administered internally to very young children or used as a gargle when possible.

Inflammation of the gums during teething must be relieved by lancing.

Simple Hypertrophy of the Gums, in the form of pendulous fringed outgrowth overlapping the teeth, is occasionally met with in young children. The cause of the condition is uncertain, but it is remarkable that the children in all recorded cases were deficient in intellect. In a case of this kind under my care I fully removed the growth with the scalpel and scissors. It was found to consist of the ordinary structure of the gums, with fine fibrous stroma containing much gland-tissue ; the papillæ on the surface were very large, and covered by unusually thick epithelium. At the time of the operation the child was 2½ years of age. Five years afterwards the late John Murray exhibited this patient and his younger brother and sister at the Medico-Chirurgical Society (Trans., Vol. LVI.). The growth had returned and the two younger children were similarly affected. They were all the subjects of tumours of the skin of the nature of molluscum fibrosum and peculiar enlargements of the fingers and toes, and were all of weak intellect. No cause could be found for the disease beyond the fact that the parents were first cousins. C. Heath recommends in such cases that the alveolar border should be removed with the growth.

Epulis is a tumour springing from the periosteum and edge of the alveolus,

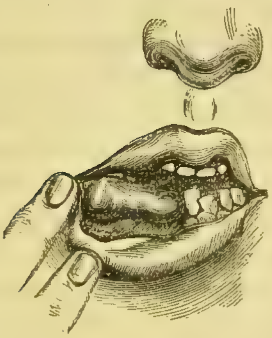


Fig. 683.—Epulis of Lower Jaw.

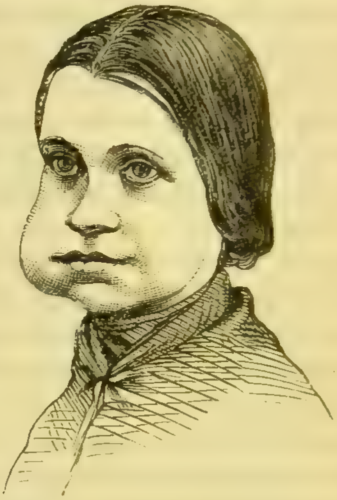


Fig 684.--Epulis of Upper Jaw, hanging down so as to overlap the Lower Jaw.

and implicating the osseous walls of the sockets ; it grows up between and loosens the neighbouring teeth, which it displaces and envelopes in its structure. It is of two kinds : *simple* and *malignant.* The *Simple Epulis* is a fibrous tumour ; the term *Malignant Epulis* is applied to a myeloid sarcoma springing from the alveolar border of the jaw, and it is sometimes extended to epithelioma of the gum.

Simple Epulis is most frequently met with in the lower jaw (Fig. 683). I have, however, seen several instances of its springing from the alveolar border of the upper jaw (Fig. 684). It appears to be occasioned chiefly by the irritation of decayed stumps, and hence occurs more frequently in connection with the molar than with the incisor teeth. Although this disease has occasionally been seen in children, it seldom occurs before the adult age, and may be developed even up to an advanced period of life. It is seen as often among females as males. A fibrous epulis appears as a red, smooth, and lobulated tumour, at first hard and semi-elastic, like the ordinary structure of the gum, but after a time ulcerating on the surface, with a purulent or sanious discharge. The fibrous epulis springs from the periosteum, and sometimes contains spicula of bone. It is covered by a thin layer of mucous membrane.

Treatment of simple fibrous epulis consists in the removal of the whole of the mass. If it be very small and superficial the growth alone may be removed and the surface from which it springs scraped with a gouge. By this means it may occasionally be cured, but more commonly it evinces a great tendency to reproduction. The portion of the alveolar border from which it springs must then be removed as well. In all ordinary cases of simple epulis, the removal may be done from the inside of the mouth without the necessity of making any incisions through the cheek. In very large masses of epulis extending towards the ramus, it may be necessary either to carry an incision from the angle of the mouth downwards and outwards, or to dissect up the cheek from the bone, and thus expose the disease fully. In performing the operation, the first thing to be done is to extract a tooth on each side of the tumour ; a cut must then be made with a saw through the alveoli of the teeth that have been removed, down to a level with the base of the growth. In doing this care must be taken not to cut too near the remaining teeth, lest the alveoli be opened and their support lost. If the tumour be large it may be necessary to saw deeply ; but the base of the lower jaw should, whenever practicable, be left intact, the whole of its substance not being sawn through, so that, though a considerable portion of bone be removed, yet the length of the jaw may be preserved. For this purpose Hey's saw should not be used, as it is a niggling instrument, difficult to manage in this situation ; but a straight and stiff-backed saw, with as deep a blade as the mouth will conveniently admit, will be found most useful (Fig. 692). The epulis, included between two vertical cuts, may now, if small, be removed with cross-cutting forceps, and the bleeding stopped by placing a plug in the wound and compressing it against the teeth of the upper jaw by means of a bandage passed under the chin. If the epulis be large, a horizontal cut should be made along the bone about midway between the alveolus and the base, by means of Hey's saw ; and, after the bone has been penetrated to a sufficient depth, the blade of the cross-cutting forceps may be fixed in this cut, and the diseased part then removed. Should there be a spouting dental artery, it may be necessary to apply a red-hot wire, or the perchloride of iron, in order to arrest its bleeding. The cut surface will speedily granulate ; and the cavity fills up with fibrous tissue. The operation for the removal of epulis is a very safe one. Of 28 cases collected by Hutchinson from different London hospitals, only one was fatal, from pyæmia.

Malignant Epulis.—By this term is commonly meant a myeloid sarcoma of the alveolar border, but it is occasionally extended to epithelioma of the gum.

Myeloid Sarcoma of the Alveolar Border forms a soft purplish, very vascular tumour, growing rapidly and speedily recurring after removal, unless the incisions are carried widely beyond the growth. It occurs principally, so far as my observation goes, in males advanced in life. These tumours require the same operation as the simple epulis ; and, as much hæmorrhage usually follows their removal, a cautery must be applied to the bleeding surface. If a malignant epulis be very large, it may be necessary to remove a portion of the whole thickness of the bone, through an external incision, as will be described in the section on Excision of the Lower Jaw (p. 625).

Epithelioma of the Gum is not common. It presents the ordinary characters of epithelial cancer. It is distinguished from myeloid sarcoma by its flat surface, its early ulceration, the everted edge of the ulcer, and its comparatively slight tendency to fungate. In the later stages the neighbouring lymphatic glands become enlarged. In the lower jaw, when the growth penetrates the compact bone, it extends widely in the cancellous tissue. In the upper jaw it may invade the antrum, and completely fill that cavity. The treatment is to remove the growth freely with a considerable portion of the bone on each side of it. In the upper jaw, if the growth fills the antrum, it may be necessary to remove the whole or a great part of the upper maxilla.

Necrosis of the Jaw is commonly the effect of blows, of salivation by mercury, of syphilis, of fever, or of exposure to the fumes of phosphorus. I have, however, seen the disease occur idiopathically in otherwise healthy subjects, without any assignable cause. In this way I have seen the whole of the alveolar process of the upper jaw exfoliate in a young lady, otherwise perfectly healthy ; and I have several times had occasion to remove large portions of the lower jaw—in one case more than half of the bone—for necrosis that could not be referred to any of the causes mentioned above, or indeed to any assignable reason. The disease begins with deeply seated pain resembling inveterate toothache, which nothing will allay ; the gums become swollen ; the teeth are loosened, and eventually drop out. Before they do so, however, pus usually wells up through the alveoli. Abscesses form inside the mouth, and under the angles of the jaw, having fistulous openings through which bare bone is reached by the probe. The general health suffers greatly, doubtless in consequence of the patient swallowing some of the pus from the dead bone.

Necrosis of the jaws, arising from inhalation of the fumes of phosphorus during the manufacture of lucifer matches, first noticed by Lorinser of Vienna, has been especially described by Von Bibra and Geist, who had abundant opportunities of observing the disease at the large manufactories at Nuremberg. This **Lucifer Match disease** was some years ago very frequent, but, in consequence of the adoption of precautionary measures, is now much more rarely met with. It consists in necrosis of the jaws, and is attended with the symptoms above described, but in a more severe degree and an acute form. The affected bone undergoes a remarkable change, assuming the porous aspect and grey colour of dirty pumice-stone. Both jaws are equally liable to be affected ; but commonly one only at a time is diseased ; the whole of the bone may die and be separated. Thus of 51 cases observed by Von Bibra, both jaws were affected in five instances only—the upper alone in 21 cases, the lower in 25. According to Langenbeck, the local disease is preceded in many instances by general symptoms of phosphorus-poisoning ; and there is a considerable amount of bony deposit from periostitis, enclosing the necrosed bone. It has been believed that workmen having sound teeth are not easily if at all influenced by the fumes, and that the phosphorus acts through carious teeth ; but Langenbeck has observed that the teeth have been sound in cases of the disease. Mears of Philadelphia, who has seen a large number of cases, is also of opinion that the necrosis is due to the general and not the local effect of the poison.

The *diagnosis* of necrosis of the lower jaw is usually unaccompanied by any difficulty. In the upper jaw, especially when limited to the palate process, it may resemble epithelioma in the raised and everted edges of the ulcer in the hard palate and the spongy feel communicated to the probe by the dead bone.

Treatment.—The treatment of necrosis of the jaws presents nothing special. The removal of the sequestra should be effected as far as practicable through the interior of the mouth, by free incisions through the gums.

In the *upper* jaw, where the necrosis seldom extends beyond the alveolar border or the palatal process, this may always readily be done.

In the *lower* jaw, the question as to whether the dead bone should be extracted through the inside of the mouth, or by incision from without through the cheek, will be determined partly by the position of the sinuses and partly by the situation and extent of the bone affected. This may in a great measure be ascertained by the situation of the sinuses leading down to it. If these be in the cheek, or in the side of the neck, or under the angle of the jaw, it is usually an indication that, if the whole of the corresponding ramus or body of the bone be not involved, the posterior and outer parts are certainly affected; and, in these circumstances, extraction of the sequestrum is best effected by opening up the sinuses parallel to the line of the jaw, and removing the necrosed bone in the usual way. The incisions for this purpose need not usually be very extensive. If the operation be delayed, in accordance with those principles that guide us in the management of necrosed bone generally, until the sequestrum is quite loose, it may usually be readily extracted, in whole or in pieces, through an opening that will leave but a small cicatrix. By such operations as these, the whole of the lower jaw has been extracted piecemeal at intervals in a state of necrosis, first on one and then on the other side. Carnochan has removed the whole of the necrosed lower jaw at one operation, disarticulating first one and then the other condyle in the usual way.

If, however, there be no external abscess or sinus—if the gum have been loosened and perforated, with a ragged portion of sequestrum projecting through it into the cavity of the mouth, then no external incisions will be required, but the dead bone may readily be removed from within the mouth. Large portions of the jaw may thus be removed. I have taken away the whole of the ramus with its processes, entirely through the gums, without any external incision: and, in a negro, the whole of the bone in a state of necrosis has thus been removed in separate pieces, by Perry, through the inside of the mouth.

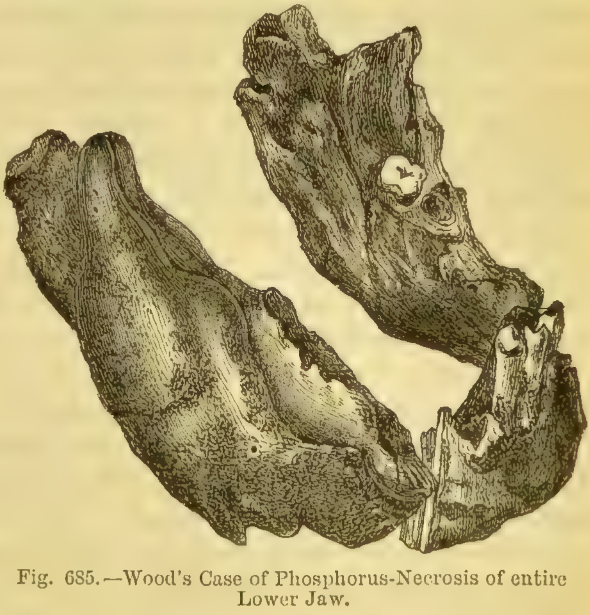


Fig. 685.—Wood's Case of Phosphorus-Necrosis of entire Lower Jaw.

Reproduction of the Jaw after Removal.—The amount of regeneration of bone will depend greatly upon the state of the periosteum before the removal of the sequestra. If this be healthy, and if new bone have already formed prior to operation, a very perfect reproduction may take place; in fact, complete reproduction of the whole of the lower jaw, though in a somewhat rudimentary and imperfect form, may follow its removal for phosphorus-necrosis. In the museum of the

Bellevue Hospital, New York, Wood showed me two specimens, one of the necrosed lower jaw, removed by him for phosphorus-disease from a girl about 19 (Fig. 685). She died of brain-disease three years after operation; and in the same collection is her cranium with a reproduced lower jaw, consisting of an entire semicircle of bone, about 5-8ths of an inch deep, with all the epiphyses. This unique and most interesting case has already been described, and the regenerated bone figured (Vol. II., p. 296, Fig. 511). In it the periosteum must have been preserved entire, and thus led to the reproduction of the bone. Should no new bone have formed before the operation, a dense fibroid cicatricial structure will replace the lost bone.

ACTINOMYCOSIS.

ANTINOMYCOSIS is a chronic infective disease caused by the invasion of the tissues by a microscopic fungus to which the name of *actinomyces* or *ray fungus* has been given. It may be conveniently described here, for although the fungus may invade the respiratory passages or alimentary tract, in the cases coming under the care of the Surgeon the disease usually commences in the neighbourhood of the jaws. Actinomycosis was first recognised as a specific disease in cattle by Bollinger in 1877, and in the same year Israel first described its occurrence in man. It was further investigated in 1879 by Ponfick, and Moosbrugger in 1886 collected from different sources 75 cases occurring in the human subject.

Pathology.—The disease is characterised both in animals and man by the formation of tumour-like masses of granulation-tissue invading the tissues in which they lie. Scattered through the granulation-tissue are small yellowish bodies about the size of hemp-seeds, which on microscopic examination are found to be composed of a central mass of closely interwoven threads, and an outer part made up of club-shaped bodies radiating from the centre, giving the whole the appearance of a rosette. It is the presence of this fungus that sets up the inflammation and causes the formation of the granulation-tissue; the large tumour-like masses being formed by the coalescence of numbers of small nodules. In some of these nodules a zone of epithelioid or giant cells may be seen surrounding the fungus, and in others a varying amount of fibrous tissue may be found apparently developed in the granulation-tissue furthest removed from the fungus. After a time varying from a few weeks to a few months the granulation-tissue round the fungus softens and breaks down into pus. According to Moosbrugger this only occurs when the diseased tissue becomes infected with the micrococci of suppuration. The abscess thus formed reaches the surface and discharges pus in which the yellow bodies above mentioned can be recognised. As the disease advances new masses of granulation-tissue spring up in the neighbourhood of the first, apparently by invasion through the lymphatics.

The fungus has so far not been successfully cultivated out of the body, nor is its natural habitat known. There is no evidence that it is in any way communicated from animals to man. It is supposed to gain entrance by some breach of continuity of the mucous membrane of the gum or mouth, or by some diseased point such as a carious tooth, or possibly, in some cases, an inflamed tonsil. It has been successfully inoculated on calves but not on rabbits or dogs.

Situation.—In the cow the disease most commonly commences in the cancellous tissue of the lower jaw, destroying the bone, and gradually reaching the surface in such a way that it was formerly mistaken for some form of sarcoma. In man this mode of origin is very rare. It usually commences either in contact with the lower or upper jaw, or in the submaxillary region. From its point of origin it may spread backwards if it starts from the upper jaw to the base of the skull, pharynx or vertebral column, or downwards to the clavicle if it begins in the submaxillary region. It has been known to invade the spine, causing caries of the vertebræ.

Symptoms.—The cases that come under the care of the Surgeon commence most commonly as a hard swelling, often painless, either attached to the lower jaw or near it in the submaxillary region. The tumour slowly increases and new centres may appear near it. After some weeks or months it becomes adherent to the skin, softens and bursts, discharging unhealthy curdy pus, in which the yellowish fungoid masses may be recognised. A sinus is then left leading to an unhealthy cavity. When it commences in the upper jaw the sinuses may perforate the cheek. If it spreads backwards towards the spine and pharynx a deep prevertebral abscess may form which may reach down to the mediastinum, and openings may form at the side of the neck leading to deep sinuses. There may be severe fever after the abscesses have opened. Death may take place either from the effects of the deep abscesses or from infection of the lungs or other viscera.

Treatment.—If the tumour is superficial, as it usually is when it commences in or near the lower jaw, it must be freely incised, and the unhealthy granulation-tissue scraped away with a sharp spoon. This operation is almost always successful in effecting a cure. In more deeply seated cases the sinuses may be scraped, but the prospect of cure is much less.

DISEASES OF THE ANTRUM AND UPPER JAW.

Our present knowledge of the operative procedures necessary for the removal of diseases of the jaws, is due chiefly to the labours of Gensoul, of Lizars, and of Liston. Sir W. Fergusson and C. Heath have also done much to simplify and extend this department of Surgery.

The various large and irregular cavities that lie amongst the bones of the face may become the seat of disease, primarily originating either in the mucous membrane by which they are lined, or in the osseous structures that compose their walls. In this way the frontal sinuses, the ethmoidal and sphenoidal cells, and the antrum, may either be seats of chronic inflammation of their mucous linings, with more or less profuse muco-purulent discharge ; or the mucous membrane may be affected by more serious organic disease. Thus epithelioma may develop in it, and after distending the cavity in which it originally formed, may destroy its osseous walls ; and, thus passing outwards into other situations about the face and the base of the skull, where it is freed from the pressure of surrounding bone, it may increase rapidly, blocking up mucous canals, as the nose and the lachrymal sac and duct, displacing the eye, and producing great disfigurement of the side of the face. These secondary outgrowths, from the rapidity of their unrestrained development, and the amount of deformity and distress which they occasion, may readily be mistaken for the primary disease, the real starting point of which will often be found in a deeper and more limited locality. The bones constituting the walls of these facial cavities, or the periosteum covering them, may also be the seat of other morbid growths, more particularly of enchondroma, and myeloid, spindle-celled or round-celled sarcoma. These run a similar course to the growths originating in the mucous membranes.

Suppuration in the Antrum.—Suppuration may take place in the antrum; it is usually excited by caries of one of the teeth, the fangs of which come in close relation with the cavity, viz., the first and second molar, the bicuspid, and the canine. It occasionally arises from injury. It is usually accompanied at first by deep-seated aching, throbbing, or lancinating pain in the face. This may be referred to the frontal region and thus simulate disease of the frontal sinuses. So much is this the case that it is a good rule not to operate on supposed disease of the frontal sinuses without previously exploring the antrum with a trochar. The pus as it forms in the antrum will sometimes overflow, as it were, into the nostril through the aperture into the middle fossa, and then may keep up constant irritation, with much fœtor in the nostrils. When this takes place, as the olfactory region of the nose is healthy, the patient is conscious of an unpleasant smell, but according to Heath this is not perceptible to other people. In ozæna, on the other hand, the patient is unconscious of the unpleasant smell which is perceived by others. In other cases, the pus drains through the socket of a tooth into the mouth; and much less commonly, its exit being prevented, it gives rise to enlargement of the cheek, the soft parts of which become brawny and inflamed, and the bones expanded, so that at last they are thinned to such an extent that, as in dropsy of the cavity, they crackle when pressed upon. Any portion of the wall of the cavity—the orbital, buccal, palatal, or nasal—may thus be expanded and fluctuation be felt through it; and, the lachrymal duct being

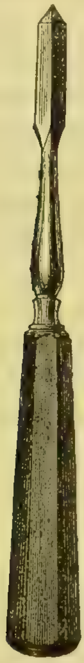


Fig. 686.

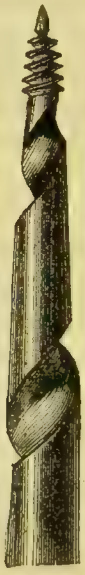


Fig. 687.

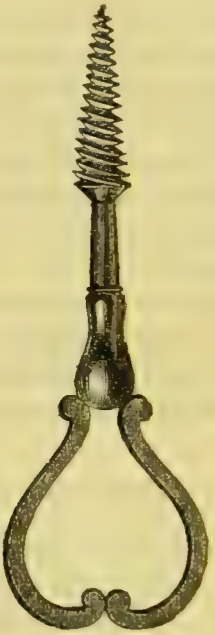


Fig. 688.

Various forms of Antrum-Perforator.

commonly obstructed, the eye on the affected side becomes watery. In some cases abscess of the antrum has been followed by loss of sight in the eye of the same side. Temporary blindness is not uncommon when the floor of the orbit is raised by the pus.

Treatment.—The treatment of this condition consists in the extraction of any carious tooth seated in the neighbourhood of the antrum; or, if the teeth be all sound, in the removal of the second molar, the fangs of which come into close relation to, and frequently perforate the bottom of, the cavity. In this way an exit may be given to the matter; but as it will not discharge itself sufficiently freely, the antrum must be opened through the alveolus, or through the canine fossa under the cheek, provided it be much expanded in this situation, so that its cavity can be easily reached. The perforation into the antrum may readily be made, or the socket of the tooth enlarged, by means of one of the forms of antrum-perforator here represented (Figs. 686, 687, 688), or a carpenter's gimlet, as recommended by Fergusson. As the matter drains away, the cavity will gradually contract, and the deformity thus be removed. It is well not to attempt to perforate in the site of teeth that have been extracted for some time, as here the bone becomes unduly consolidated, and the attempt to reach the cavity is consequently likely to fail. The matter that is discharged is often very offensive, or it may be thick and pasty from the absorption of its watery parts. After the aperture has been made, the cavity should be syringed out twice a-day with some antiseptic solution. The best instrument for this purpose is that recommended by Heath, consisting of a common Eustachian catheter, to which an india-rubber ball is fitted to contain the fluid to be injected.

Cysts of the Antrum or **Dropsy of the Antrum.**—In this disease the antrum becomes slowly distended with a fluid, in some cases glairy and mucous in character, like the contents of a ranula, in others thin, brownish, and serous, containing cholesterine. It was formerly believed that this condition was, in some instances at least, due to obstruction of the aperture leading from the antrum to the nose, but it is now generally acknowledged that in all cases it results from the formation of a cystic tumour springing from the mucous membrane lining the cavity. In such cases the accumulation of fluid may after a time cause expansion and thinning of the osseous walls of the cavity. The cheek is rendered round and prominent—a painless indolent semi-elastic tumour forming in it and protruding it outwards, and giving rise to the egg-shell or parchment-like crackling on pressure (Fig. 689). The floor of the orbit or the roof of the mouth may be caused to bulge, and the nasal cavity may be encroached upon.

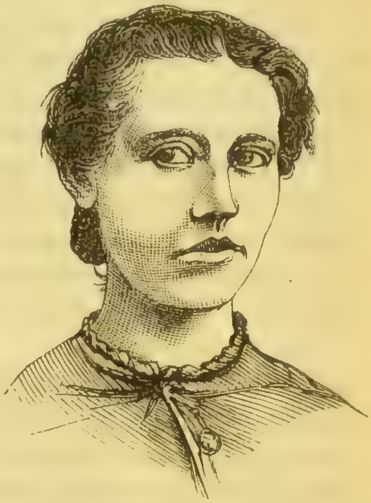


Fig. 689.—Cystic Tumour of Antrum.

Treatment.—The operation of "catheterizing the antrum," founded on an erroneous idea as to the nature of the disease, was formerly recommended, but was never attended by any benefit to the patient. The only efficient treatment consists in opening the antrum from without: this is done without incising the lips or wounding the face, by thrusting a trochar and cannula into the most thinned and expanded part of the tumour under the cheek; or, if necessary, by dissecting up the cheek from the gum, and thus making an opening into the cavity of the antrum with a strong pair of scissors or a perforator, through its most expanded part, so as to allow the discharge to escape freely. In order to prevent a re-accumulation of the fluid, it will be better to cut away a small portion of the expanded wall of the antrum, and thus to establish a permanent aperture in it, through which it must be syringed out daily with some antiseptic solution until all discharge ceases.

Polypus of the Antrum.—Mucous polypi are occasionally met with in the antrum, but they give rise to no symptoms unless they reach a size sufficient to cause distension of the cavity. They then most commonly cause absorption of the inner wall and project into the nasal cavity, from which they have been successfully removed with forceps.

Dentigerous Cysts.—These may, according to Christopher Heath, occur in either jaw. They arise in connection with teeth which from some cause have been retained in the jaw. They are almost invariably connected with the permanent teeth. Tomes believes that they arise from the excessive formation around a retained tooth of a fluid which is normally found after the complete development of the enamel, between it and the soft tissues investing it. The tooth is not unfrequently found to be inverted. The cysts may occur at any age, but are most common in young adults. In the upper jaw they may form cysts in the antrum. In the lower jaw, they form prominent isolated tumours. They have been mistaken for solid tumours, and the jaw has in consequence been partially removed. Occasionally they may suppurate. Heath mentions also *dentinal tumours*, *i.e.*, irregular masses of dentine growing from a tooth and forming tumours of the jaw; but they seem to be very rare. The treatment consists in cutting away a part of the wall of the cyst and removing the retained tooth. The subsequent treatment is the same as that of cyst of the antrum.

SOLID TUMOURS of various kinds may take their origin from the superior maxilla or its immediate neighbourhood. In most cases, by the time the case comes under observation, it is impossible to say with certainty in what part or tissue it took its origin—whether it began in the upper jaw, or spread into it from contiguous structures. The following are the chief tumours met with in this region.

Fibroma.—This is not uncommon, springing from the periosteum and either filling the antrum or projecting from the alveolar border. It grows slowly, and has no tendency to infect the surrounding tissues, but when springing from the antrum it causes gradual absorption of the surrounding bone, and forces its way into the neighbouring sinuses and cavities, or projects forwards on the face, sometimes forming a tumour of considerable size.

Enchondroma.—Pure enchondroma is uncommon; its general mode of growth, and the appearance it gives rise to, are similar to those of fibroma.

Osteoma.—Bony growths are occasionally met with filling the antrum and causing a projection forwards on the cheek. They are composed of tissue having the normal structure of bone, and somewhat denser in structure than ordinary cancellous tissue. They increase slowly and painlessly. A case of this kind occurring in a young woman, aged 25, was recently in University College Hospital, under the care of C. Heath. It formed a considerable projection on the face, and had been growing for ten years. Pedunculated growths have been met with springing from the outer surface of the bone, and still more rarely ivory-like tumours have been found in the same situation.

Vascular Tumours.—Liston removed a tumour from the maxillary region, which in section presented the appearance of erectile tissue. The specimen is now in the Museum of University College. The section closely resembles that of the corpus cavernosum penis.

Sarcomata of various kinds are of frequent occurrence in the upper jaw, originating in the maxilla itself, or in the surrounding bones. Spindle-celled and round-celled sarcoma, in some cases undergoing partial ossification, and in others developing into cartilage, are the varieties chiefly met with. They form soft, rapidly-growing tumours, often implicating the surrounding parts and pushing into the neighbouring cavities from an early period. They are extremely vascular, so much so that in rare cases they pulsate distinctly. When they project into the nose they form polypoid masses, bleeding readily and obstructing the fossæ. If they spring from behind the maxilla, they not unfrequently penetrate the cranial cavity, either from the orbit or by means of the foramina in the base of the skull. Myeloid sarcoma occurs in young adult life chiefly in the alveolar border of the bone. In other parts it is extremely rare.

Epithelioma is far from uncommon. It may, as before stated, spring from the gum and penetrate the antrum, or it may originate in the mucous membrane of the antrum or nasal fossæ. It forms a soft rapidly-growing tumour, infiltrating the surrounding parts. It very early spreads into the irregular cavities in the neighbourhood of the upper jaw, and thus is very apt to recur after apparently complete removal. The form most commonly met with is the squamous epithelioma spreading from the hard palate or gum, but columnar or tubular epithelioma originating in the antrum or in the nasal fossæ is also met with.

Situation and Symptoms of Tumours in the Region of the Upper Jaw.—Sarcomatous tumours occasionally spring from the surface of the malar bone, pushing forward the cheek, spreading into the mouth, and involving, with greater or less rapidity, according to their malignancy, the soft structures of the face and occasionally the lymphatic glands under the jaw. They are usually rapid in growth, soft and elastic to the feel, irregular in outline, and only secondarily implicate the superior maxilla and the neighbouring cavities.

The various growths that are connected with, or spring from, the periosteum or mucous membrane of the antrum, in growing gradually expand and dilate the walls of the cavity, pressing the bones outwards, thinning them, and giving rise to a considerable projection of one side of the face, the anterior surface of the superior maxilla being the part that usually first yields to the outward pressure. The tumour thus formed is generally smooth, round, or oval, slightly lobed perhaps, more especially if fibrous, and has in many cases a tendency to hang downwards so as to overlap the lower jaw to a certain extent. As it grows, it encroaches more or less upon the structures lying in the vicinity of the antrum. Thus, it pushes down the palate, causing swelling in the roof of the mouth ; displaces the alveolar processes and teeth, giving rise to irregularity in their outline, and tending to project into and occupy the alveoli. It may obstruct the lachrymal duct, occasioning epiphora, or encroach upon the orbit, causing impairment of vision, and displacement of the eyeball. As the tumour enlarges, it obstructs the nasal cavity, and, stretching back into the pharynx, interferes with respiration and deglutition, and sometimes occasions severe epistaxis. When it is of a malignant character, obstruction of the nasal fossa will be found to be one of its earliest signs, leading to the suspicion of nasal polypus ; but the true and more serious nature of the disease will be revealed by the integuments becoming involved, the gums implicated, and perhaps the submaxillary lymphatic glands enlarged.

Diagnosis.—In the diagnosis of these tumours growing in the upper jaw, there are three principal points to be attended to :—1, to distinguish the growth from fluid accumulation ; 2, to determine whether it be simple or malignant ; and 3, to ascertain its primary seat.

1. In making the diagnosis from *fluid accumulation in the antrum*, the history of the case, and the uniform enlargement of the cavity without localized projection beyond any part of its walls, the elasticity and even fluctuation that may, after a time, be detected, more particularly towards the outer side of the swelling, and at the junction of the mucous membrane of the cheek and the gum, will enable the Surgeon to determine that it is not solid. But in many cases that is not sufficient ; and it becomes necessary to make an exploratory puncture by means of the perforator, through one or other of the more thinned and expanded parts already indicated. This should never be omitted in cases of doubt : for it has happened even to so good a Surgeon as Gensoul that, after making incisions through the cheek with the view of extirpating the tumour, the bones were found to be expanded by an antral abscess, and that, consequently, the operation had been undertaken unnecessarily.

2. In determining whether the growth be *simple or malignant*, the Surgeon will experience much difficulty, so long as it is confined to the cavity of the antrum ; but when once it has perforated and passed beyond its walls, this point is easily solved. Yet, even whilst the tumour is still confined within the antrum, much light may be thrown upon its nature by attention to the rapidity of its growth ; the greater this is, the more reason there is to suspect that it is malignant. Too much importance, however, must not be attached to this sign ; for though, as a general rule, fibrous, cartilaginous, and bony tumours may increase less rapidly than the malignant, yet they may attain a very great bulk in a short space of time. The age of the patient is of comparatively little value in the diagnosis ; I think, however, that, as a general rule, simple tumours more frequently occur in the young, whilst the malignant forms of the affection are more commonly met with at the middle or advanced periods of life. When the disease is malignant, the submaxillary lymphatic glands often become enlarged and indurated at an early period. In a case under my care, the malignant character of a tumour, whilst still in the antrum, was determined by the fact of there being a long chain of indurated lymphatic glands lying under the angle of the lower jaw. It must be remembered, however, that the sarcomata, which run an essentially malignant course, infiltrating surrounding parts and recurring in internal organs, do not as a rule affect the lymphatic glands. When once a malignant tumour has passed beyond the cavity of the antrum, and is thus relieved from the pressure of its walls, it grows with great rapidity, and where it can be felt under the skin, is perceived to be soft and elastic. Insinuating itself extensively amongst the bones of the face and skull, it creeps through the foramina and fissures, and encroaches greatly on the nasal cavity and orbit ; its early protrusion into these cavities is especially

characteristic of malignancy. It implicates the integuments of the cheek, with an inflammatory œdema, and the soft structures within the mouth, and throws out sprouting masses in these several situations, which present all the characters of the true malignant fungus.

3. A point of very great importance in relation to operative interference is to determine the *primary seat of the tumour;* whether it spring from the cavity of the antrum, from the malar bone, or from behind the superior maxilla in the pterygo-maxillary fossa. When it springs from the *interior of the antrum*, the buccal, orbital, nasal, or palatal walls of that cavity are expanded, and the line of teeth is rendered irregular. When the tumour primarily springs from the *malar bone* (Fig. 690), it pushes forward the cheek into a somewhat conical prominence, and dips down into the mouth between the gums and the soft structures of the face. It does not involve the palate, or alter the line of the teeth; but rather spreads over the bones, and involves the covering soft parts by continuity of tissue, without any definite anatomical disposition. As the tumour increases in size, it will implicate the anterior wall of the antrum, and thus secondarily project into that cavity. When the disease develops primarily *behind the superior maxilla*, between it and the great ala or the pterygoid process of the sphenoid, the upper jaw-bone is simply pushed bodily forwards, there being little if any deformity in its outline, the line of teeth not being displaced, nor the walls of the antrum—palatal, nasal, or orbital—expanded. Yet it must be borne in mind that the difficulty of diagnosis is greatly increased by the fact that a tumour, though not originating in the antrum, may find its way at an early period of its growth into this cavity, or may pass into the orbit through the spheno-maxillary fissure, and may make its way forwards amongst the bones of the face, partly by creeping through, and partly by absorbing and displacing them.

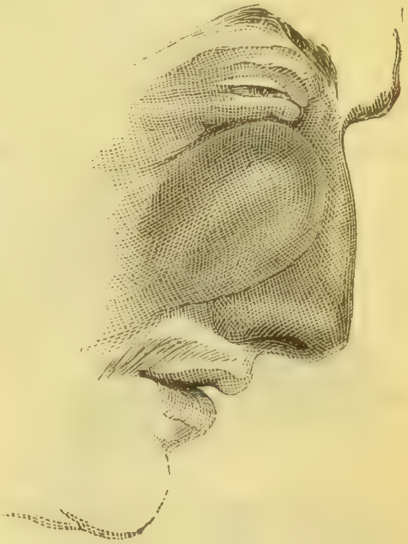


Fig. 690.—Malignant Disease of Malar Bone not suitable for operation.

Treatment.—In the treatment of tumour of the upper jaw and antrum, nothing can be done except to extirpate the growth; and it is consequently of great importance to distinguish those forms of the disease in which an operation can be undertaken with safety, and with a fair chance of success, from those in which none should be performed. The points to be considered are: 1, whether the tumour is benign or malignant; 2, if it be benign, whether it grows from the antrum or springs from behind the superior maxilla; or 3, if it is malignant, whether it has passed the boundaries of the antrum. When the tumour, springing from the antrum, is of a simple character, the disease should be removed, together with the whole of the superior maxilla; the tumour, whatever size it has attained, being generally encapsuled, and the bones expanded and absorbed around it; so that it is well bounded, and does not implicate neighbouring parts. Here, as Liston justly observes, no nibbling or grubbing operations, but free excision of the whole mass, should be practised. When the tumour springs from the spheno-maxillary or pterygo-maxillary fossa, pushing the bones of the side of the face forwards, an operation should not be lightly undertaken, as it is doubtful, in many cases, whether the Surgeon can interfere with any prospect of success. Should, however, the tumour be simple, the patient's health be good, and an operation be deemed expedient, the tumour can be reached only by excising the upper jaw, when it may either be removed attached to that bone, or it may be extirpated from the cavity in which it lies behind it. Such an operation, implicating as it does the base of the skull, may be followed by death from shock to the nervous centres, as I saw happen in a patient of Liston's thus operated upon; or, involving the internal maxillary artery, may be attended by very profuse and troublesome hæmorrhage. When once a malignant growth of this part has passed beyond the osseous boundaries of the antrum, the question of removal becomes very complicated. In reference to this point, I think that it may be stated generally that, if the cheek be freely movable over the tumour, and the lymphatic glands unaffected, the operation may be proceeded with. But, if it have advanced so far as to implicate the soft structures of the cheek, with enlargement of the submaxillary lymphatic glands, it is neither wise nor prudent to interfere with it by operation; as infiltration will have taken place more widely than the knife can reach, and speedy recurrence must of necessity ensue. So long as it is contained within the cavity of the antrum, where indeed it is often impossible to ascertain, until after removal, the true nature of the affection, it may be excised, provided the glands in the neck be not enlarged. If they be much implicated, even though the walls of the antrum be not perforated, it is wrong to interfere, as a cure by operative procedure must be hopeless. Whenever the soft structures of the cheek are involved so as to require partial excision with the tumour, no operation should be performed; as it cannot be completely extirpated, and will speedily recur in the cicatrix. When the upper jaw on both sides is affected, as sometimes has happened, it is very rarely that any operation is possible (Fig. 691).

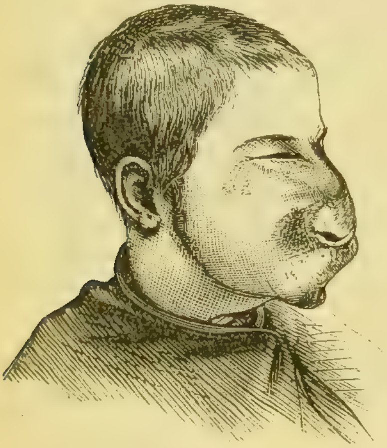


Fig. 691.—Malignant Tumour of the Upper Jaw, involving the whole of the Bones of the Face; not admitting of operation.

Operations on the Upper Jaw.—The *Operations* that have been practised for the removal of tumours springing from the upper jaw are of three kinds. They consist of—1, Scooping out of the Tumour; 2, Partial Excision of the Superior Maxilla; and 3, its Complete Removal with or without the Malar Bone.

For operations on the upper jaw, the Surgeon will require strong cutting pliers, and two or three narrow-bladed saws, with handles set at different angles, and having movable backs (Fig. 692).

1. **Scooping out the Tumour.**—The practice of scooping out tumours of the antrum, after turning up the cheek from the anterior surface of the superior maxilla, is one on the propriety of which there is a difference of opinion among Surgeons. Liston, whose experience in these diseases was in his day unrivalled, denounced all "grubbing" operations; and Syme strongly dis-

approved of the practice. But other Surgeons, whose views on the subject are entitled to the highest respect, advocate and practise this proceeding. For my own part, I look upon the practice as unscientific in principle and disastrous in its results. It is applicable only to the softer kinds of tumours, and these are chiefly sarcomata. Now I hold it to be impossible by gouging, scooping, chiselling, or scraping, to extirpate these completely from any bone in which they may be developed. It is impossible in this way fairly to go beyond the limits of the disease into healthy structures. Tissues that appear and feel sound, are in reality infiltrated: and hence speedy recurrence takes place. This has happened in every case in which I have seen this operation practised; and the recurrent is worse in all its features—more rapid, more luxuriant, more malignant—than the primary disease. In fact, there is no reason why, in operations on the jaws, we should depart from that principle which is found necessary in operations on other parts for the removal of malignant growths, of being guided in the extent of the removal by the anatomical boundaries of the part affected, and not by the apparent extent of diseased structure. It seems to me to be as reasonable to scoop a myeloid or a malignant tumour out of the head of the tibia instead of amputating the affected bone, as it is to scrape it out of the antrum, instead of extirpating the superior maxilla.

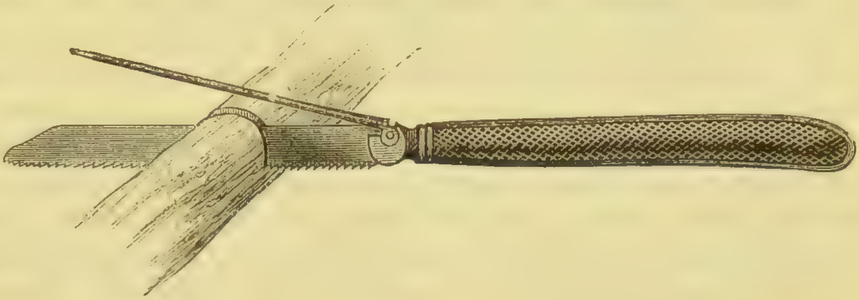


Fig. 692.—Saw with Movable Back, for Operations on the Jaws.

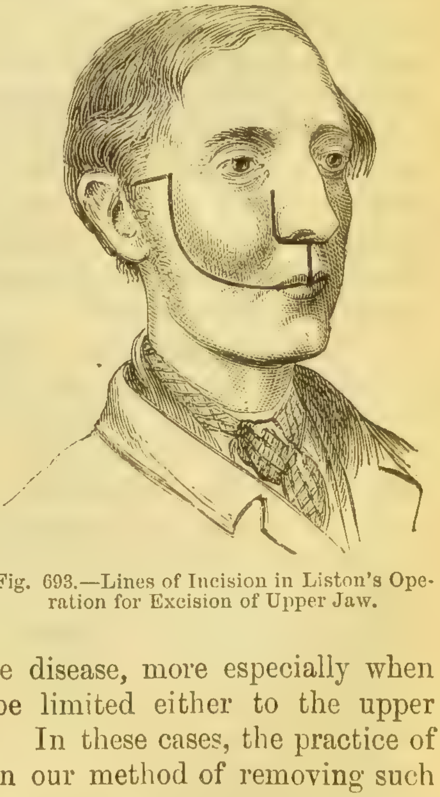


Fig. 693.—Lines of Incision in Liston's Operation for Excision of Upper Jaw.

2. **Partial Excision of the Superior Maxilla.**—Although I do not consider the scooping away of the tumour from the antrum to be a proper or surgical procedure, I would not advocate the removal of more of the bones of the face than is absolutely necessary for the complete extirpation of the disease, more especially when that is not malignant. The disease may be limited either to the upper or to the lower part of the superior maxilla. In these cases, the practice of Sir W. Fergusson has led to great advances in our method of removing such disease with the least possible disfigurement and the least loss of bone. With regard to the external incisions in these cases, Fergusson has shown that they often need to be but very limited; all that is necessary being a cut from the

angle of the mouth upwards and outwards through the cheek, or, in other cases, a slit through the upper lip in the mesial line, the knife being carried along the side of the columna into the nostril. By these simple incisions, this distinguished Surgeon has shown, sufficient relaxation of parts can be obtained for the excision of the greater part of the superior maxillary bone.

In some cases, the malar bone and floor of the orbit will be found to be sound. When this happens, they should both be left ; and with this view, after the cheek has been incised as just described, a deep horizontal groove should be made with a narrow straight-backed saw below the orbit, directly across from the nasal process of the maxillary to the edge of the malar bone. The forceps should now be applied so as to cut downwards and outwards from the end of this incision, and thus to sever the connection between the superior maxilla and the malar bone. They are then to cut along the groove that has been traced horizontally with the saw, one blade cutting from the nares along this ; and lastly, the alveolus and hard palate have to be divided. This is best done after the extraction of one of the central incisors, by passing a narrow-bladed saw into the anterior nares and cutting down through the alveolus ; the remainder of the section being completed with the forceps. Or the proceeding may be reversed, and the cut made from the mouth up towards the nasal cavity. Should the disease implicate chiefly the upper orbital and nasal portions of the bone, leaving the cheek and roof of the mouth sound, another modification of the operation may be undertaken by carrying the knife from the nasal process down the side of the nose and from the nostril across the cheek, dissecting up the flap thus formed. The palpebral ligament must then be cut through, and the fat of the orbit pushed upwards and held on one side with a copper spatula, which at the same time protects the eye from injury. The nasal process of the superior maxillary bone is then cut through from the lower and inner part of the orbit into the nose ; the saw is carried from the anterior nares across the superior maxilla above its alveolar process, and from the outer end of this a perpendicular cut is carried upwards into the orbit towards its outer angle so as to extend backwards into the spheno-maxillary fissure. The cutting pliers are then carried along these lines of incision so as to loosen the bone completely and the detached portion is then lifted out by means of a curved periosteal elevator.

3. **Complete Excision of the Upper Jaw.**—The operation of excision of the whole of the upper jaw, together with the malar bone, for tumour of the antrum, was first proposed by Lizars in 1826 ; though Gensoul of Lyons was the first Surgeon by whom the operation was actually performed, in May, 1829. Since then, it has been repeatedly practised ; and the names of Liston and of Fergusson are inseparably connected with it, for the skill with which they devised, and the boldness with which they carried out the various steps of its performance.

The patient should be placed in a recumbent position with the head and shoulders well raised by pillows, opposite a good light. The Surgeon stands at first on the same side as the bone to be removed, but during the sawing he will find it convenient to stand always on the right side, returning to the left, if that be the affected side, during the final stages of the operation. Hæmorrhage during the operation is one of the chief difficulties, not only on account of the actual loss of blood that may take place, but from the risk of asphyxia from the blood finding its way into the larynx. In order to prevent this accident the throat must be frequently wiped out during the operation with sponges fixed upon proper holders. Annandale has recommended that the operation should be done with the patient's head hanging over the end of the table, so that any blood that runs backwards may accumulate in the upper part of the pharynx, whence it can be removed from time to time with a sponge. This position, however, tends to aggravate the hæmorrhage, and is not to be recommended when the tumour is very vascular. It will often be found useful to plug the posterior nares with a good-sized sponge passed behind the soft palate in the way already described, before commencing the operation. This tends to push the soft palate forwards, and may embarrass the breathing. Should this happen, a large tube of some kind, such as a lithotomy tube may be passed between the root of the tongue and the soft palate through which respiration can be readily carried on. During the operation a good-sized sponge, attached to a piece of string, may be placed in the mouth on the side on which the operation is being performed, care being taken to leave a sufficient space for the passage of air in respiration. It must be remembered, that the patient does not require the whole mouth to breathe through, and if it be carefully managed, a great part of the cavity may be filled with sponges during the operation. In this way, in ordinary cases, this operation may be performed without a drop of blood passing down the throat. If the tumour be very large and vascular, and much hæmorrhage is expected, it may be advisable to adopt more efficient means to prevent the risk of asphyxia. This danger may be entirely avoided by the method devised by Trendelenburg, and adopted by Langenbeck, in cases of operation about the jaws, palate, or pharynx, in which serious hæmorrhage is anticipated. The patient having been placed under the influence of chloroform, tracheotomy is performed in the usual way above the thyroid body. A trachea-tube fitted with a hollow india-rubber collar (Fig. 694, 1) is then introduced, and the inhalation of the anæsthetic vapour carried on through it by attaching, by means of an india-rubber tube, a funnel containing a sponge (Fig. 694, 2). When the Surgeon is about to commence his operation, the collar is

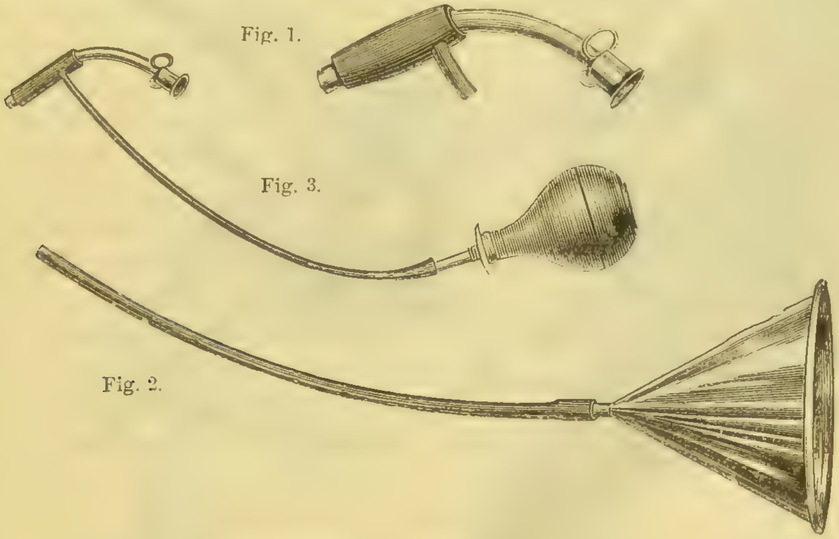


Fig. 694.—Trendelenburg's Trachea-Tampon.
1. The Trachea-tube and Collar slightly inflated. 2. The Inhaling Funnel.
3. The Inflating Bottle attached to the Collar on Trachea-tube.

inflated by means of the india-rubber ball attached (Fig. 694, 3); the effect being to close the trachea round the tube, and thus to cut off all possibility of blood finding its way down the larynx into the lungs. After the operation is completed, the "trachea-tampon" is removed, and an ordinary trachea-tube is substituted and retained as long as it may be thought necessary. If this apparatus be not at hand, the desired result may be equally well obtained by performing a preliminary laryngotomy and then plugging the pharynx with a large sponge, which can be withdrawn as soon as the operation is over. Macewen has recently suggested, that instead of opening the larynx or trachea a tube should be passed from the mouth through the glottis and the pharynx, the upper opening of the glottis being then plugged with a sponge. This he has successfully done in several cases. The tube should be of gum-elastic, and should correspond to about a No. 10 or 12 English catheter. It is passed by introducing the finger into the mouth and depressing the epiglottis on the tongue, and so guiding the tube over the back of the finger into the larynx. The patient's head should be thrown somewhat backwards while the tube is being passed.

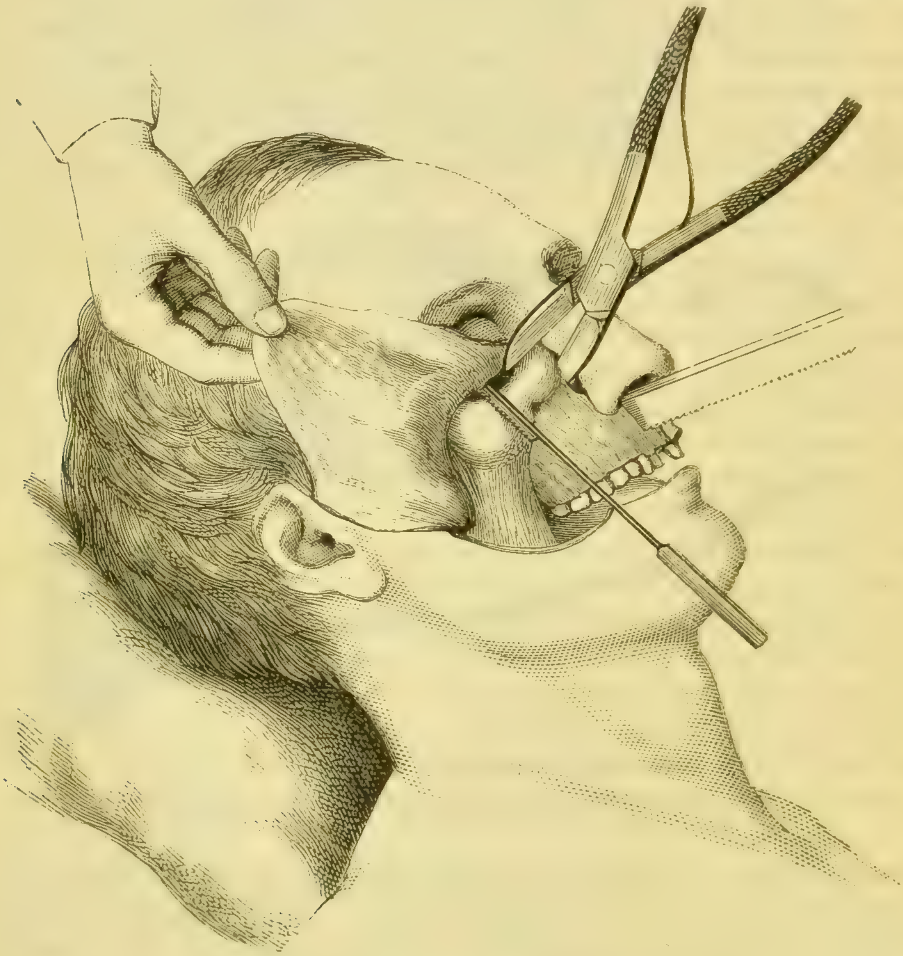


Fig. 695.—Excision of Upper Jaw by Liston's Method.

In order to diminish the loss of blood as far as possible, the facial artery may be compressed during the early incisions, and all bleeding vessels must be seized in forcipressure forceps immediately they are divided.

The parts to be removed must be fairly exposed by raising a flap from the cheek. This may be fashioned in various ways (see Figs. 693, 695, 696). The following, which is the method adopted by Liston, will occasionally be found to be convenient where the tumour is very large (Fig. 693).

In the first stage, the central incisor tooth on the diseased side having been extracted, the point of a bistoury is entered opposite the external angular process of the frontal bone, and carried with a semicircular sweep into the angle of the mouth. From the upper end of this incision, a cut about one inch in length may be carried along the zygoma. Another incision is made from the nasal process of the superior maxillary bone, down to the side of the nose, round the ala, which it detaches, and through the centre of the upper lip into the mouth. The flap thus formed is dissected upwards until the margin of the orbit is reached (Fig. 695); the soft parts are then carefully separated from the floor of this cavity, and drawn upwards by a curved copper spatula, which protects them and the globe of the eye.

The operation by the external flap (Fig. 696) is, however, preferable in all ordinary cases, and is thus carried out. The point of the knife is entered opposite the inner angle of the eye, and carried down the side of the nose, round the ala, and through the centre of the upper lip. Another incision is now made in a horizontal direction below the orbit, by entering the point of the knife where the first incision commenced, and carrying it directly outwards in the line of junction of the lower eyelid with the cheek, along the edge of the orbit as far as the zygoma. The flap thus formed is thrown outwards. This line or incision has the great advantage over the one represented in Fig. 696, that the arteries and nerves of the face are cut near their terminations, and not through their larger branches.

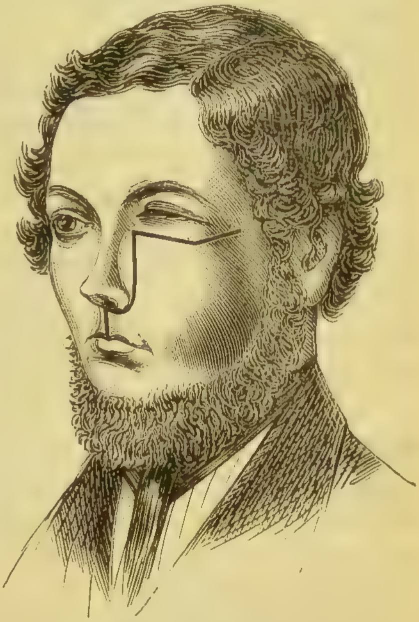


Fig. 696.—Line of Incision in Excision of the Upper Jaw by External Flap.

The next step in the operation consists in the division of the bones. This is best done with a jaw-saw and strong cutting pliers. The central incisor tooth is first extracted on the side on which the jaw is to be removed. The jaw-saw (Fig. 692) is then pushed into the nostril with its edge parallel to the hard palate. Its point must not be directed upwards for fear of injuring the cribriform plate. The saw is then carried through the alveolar border and the palate processes of the superior maxilla and palate bones, cutting through the alveolus of the incisor that has been extracted. No incision must be made with a knife through the soft structures of the hard palate as they are divided readily and with less hæmorrhage by the saw. Care must be taken not to saw so far as to injure the soft palate. A smaller saw is then taken, and the nasal process divided at the level of the lower margin of the orbit, so that the posterior extremity of the incision shall correspond to the line of the articulation between the superior maxillary and the ethmoid bones. The saw is then carried through the malar bone in such a direction as to reach the anterior extremity of the spheno-maxillary fissure. If the tumour implicates the malar bone extensively, the zygoma must be divided and another saw-cut carried from the spheno-maxillary fissure through the frontal process of the malar bone.

The cutting-pliers are now applied first to the malar bone and next to the nasal process. One blade of the bone-forceps (the flat side being directed to the sound bone) is then put into the nose, the other in the mouth in the line of the saw-cut already made. As the blades are closed the wedge-like action of the forceps forces the bone outwards and fractures its posterior attachments. Unless the bony structures are extensively destroyed by the tumour, the line of fracture runs across the ascending process of the palate bone and the middle part of the two pterygoid plates, the articulation between the superior maxillary and the palate bone, and between the tuberosity of the palate bone and the pterygoid plates being too firm to yield. The bone being now completely separated from its osseous attachments, the Surgeon seizes it in the "lion forceps" with his left hand and wrenches it downwards and outwards, while he cuts away the soft palate from its attachment to the bone, care being taken not to cut it through vertically. If at this stage the superior maxillary nerve is seen, it must be cut through. The parts of the pterygoid muscles attached to the portions of the pterygoid plates that are removed can be torn through with a little help from the scalpel or scissors. If the bone is too much broken up by the tumour to be held by the lion-forceps, it can usually be drawn forwards by the fingers. As soon as the bone comes out, a dry sponge must be forced into the cavity to arrest hæmorrhage, while the mouth and fauces are cleared of blood, and the patient, who at this stage has often partly regained consciousness, is again brought under the influence of the anæsthetic. Hæmorrhage from the terminal branches of the internal maxillary must then be arrested by the actual cautery, or, if possible, by ligature. When all bleeding has ceased, the whole cavity must be carefully examined, and any remaining fragments of the growth must be removed either with scissors or with Paquelin's cautery. If the whole growth is undoubtedly removed, the cavity is then touched with a solution of chloride of zinc (gr. 40 to ℥j), care being taken that none of the fluid passes down the throat. It should then be sprinkled with iodoform in crystals, and the cheek flap laid down. If there is any doubt about the complete removal of the growth, Heath recommends that some strips of lint spread with chloride of zinc paste should be laid in the cavity. Some pieces of dry lint may be placed over these to prevent any of the paste finding its way into the throat. The flap must be retained *in situ* by strong metallic sutures or hare-lip pins through the lip, and by finer sutures of catgut, horse-hair, or silk, along the other lines of incision. However much the skin may have been stretched and thinned, none should be removed unless it has been actually infiltrated by the tumour. The after-treatment consists in syringing the cavity out daily with Condy's fluid and water, and sprinkling the raw surface with a little iodoform by means of a camel's-hair pencil. There is nothing so efficient as iodoform in the prevention of decomposition in these cases, and by its use the danger of septic poisoning or septic pneumonia is greatly diminished. After cicatrization is complete, the patient is fitted with a proper obturator, and the deformity resulting is far less than might have been anticipated.

Results.—The result of operations for the removal of the upper jaw is very satisfactory, so far as the operation itself is concerned. Though most serious, the operation is not very dangerous. Of 17 consecutive cases collected by Hutchinson as having been practised in the London hospitals, it was successful in 14 ; and of 16 cases (10 of total and 6 of partial removal) done by Esmarch, 13 were successful (viz., 8 of the former and 5 of the latter). So far as recurrence of the disease is concerned, all will depend on the nature of the tumour, and the extent of the operation. If the disease be malignant or even myeloid, speedy recurrence will certainly ensue if partial excision or scooping be practised. Nothing, indeed, can be more disastrous than the result of partial operations in these cases. Even though the whole maxilla be excised, the incisions being carried wide of the disease, recurrence is the almost invariable rule, though the more complete operation secures longer immunity. The liability to recurrence is remarkable in these cases, when we consider how isolated the upper jaw is, being bounded on three sides by the cavities of the mouth, nose, and orbit, and how completely it can be excised. It is, I believe, mainly due to two causes—early implication of the soft parts, and extension of the mischief through the fissures and sinuses behind the bone. These recurrent malignant growths, after removal of the primary tumour, do not admit of extirpation. When the tumour is benign, the result is most satisfactory, and the cure usually complete.

Tumours that spring from behind the Superior Maxilla have already been adverted to in speaking of naso-pharyngeal tumours (p. 576), and in discussing the diagnosis of tumours of the upper jaw (p. 613). They may grow from the sphenoid bone, or from some of the deep cavities lying between it, the palate bones, and the ethmoid, constituting various forms of naso-pharyngeal, palatine, or naso-palatine polypi. Formerly these tumours were either left untouched, or were extirpated together with the superior maxilla or after its removal. Of late years various operations have been devised without the necessity of removing that bone, which is either turned up, down, or on one side. The best operation on the whole for their removal is Langenbeck's **Osteoplastic Section of the Superior Maxilla,** with displacement of that bone. The first operation was performed in 1859. Up to 1877, Langenbeck had performed it 13 times, with 10 complete cures and 3 deaths. It has been performed in Germany also by Esmarch, Wagner, Simon, Nussbaum, and Billroth. The last two performed it for removal of the superior maxillary nerve for neuralgia. In America it has been performed twice by Cheever. In one case, it was done for removal of a tumour growing from the body of the sphenoid bone ; the tumour recurred, and the operation was repeated at the end of eleven months, with perfect success. In the other case, both bones were displaced at the same operation ; but the patient died on the fifth day of "prostration with excitement." In Langenbeck's first operation, the incision was made from the middle of the nasal eminence of the frontal bone towards the right, over the nasal process of the superior maxilla and downwards to the ala of the nose. The edges of the wound were dissected up so as to expose the whole nasal process and the nasal bone, the periosteum remaining untouched. The cartilaginous portion of the nose was separated from its bony attachments. The nasal bone was then cut through with bone-forceps, close to the septum, and upwards as far as the frontal bone ; by a second cut the nasal process of the superior maxillary was divided into the antrum. The cut ended where the nasal process of the superior maxillary bone forms the lower border of the orbit. The upper part of the nasal process of the superior maxillary and the nasal bone were then prised up and were turned on to the forehead, being still attached by periosteum and mucous membrane. The nose was then fully opened, and the polypus was removed. The bones were then replaced and supported in position by a plug of charpie. The wound healed readily, and there was no exfoliation of bone. Langenbeck's second operation was undertaken for a tumour springing from behind the superior maxillary bone in the pterygo-maxillary fossa. Two incisions were made ; the first began at the insertion of the ala nasi and ran along the lower border of the malar bone, describing an arch with the convexity downwards and terminating at the middle of the zygoma ; the second began at the nasal notch of the frontal bone, and, following the lower margin of the orbit, crossed the frontal process of the superior maxillary bone, and joined the lower incision at its outer extremity. The soft parts were not dissected up. The lower incision was then carried to the bone, and the masseter dissected from its attachment to the malar bone. By depressing the lower jaw so as to remove the coronoid process out of the way, the finger could be forced in front of the anterior border of the temporal muscle into the spheno-maxillary fossa, which was dilated by the tumour, into the nose through the spheno-palatine foramen. A narrow saw was now passed along the finger—its point being protected by the forefinger of the left hand introduced into the nostril—and a cut was made directly forwards through the ascending process of the palate bone and the body of the superior maxillary bone, across the cavity of the antrum, parallel to the hard palate and immediately above it, terminating at the anterior naris. The upper incision was now deepened, and the soft parts were raised from the floor of the orbit and from the angle between the zygoma and the malar bone : and, the saw being again introduced, a cut was made through the malar bone into the spheno-maxillary fissure, and thence across the floor of the orbit as far as the lachrymal bone. The wedge-shaped piece of the superior maxillary bone included between these cuts was now attached only by its conections with the nasal and frontal bones, and by the soft parts covering it, which were untouched. By introducing an elevator into the cut in the malar bone, the whole piece was lifted up, bending upon its attachment to the nasal and frontal bones as upon a hinge, until it was completely turned inwards and upwards over the opposite side of the face. The tumour, which was found to have extensive connections in the pterygo-maxillary region, was now removed. The bone was then replaced, and the wound closed. On the sixth day, the greater part of the wound was healed ; on the sixteenth the wound had completely healed, and no mobility could be felt in the bone.

Ollier's and Lawrence's operations, which are adapted specially to tumours of the nasal fossæ, have been already described.

DISEASES OF THE LOWER JAW.

Abscess in the Lower Jaw.—Chronic abscesses, causing "expansion of the bone," have been met with in the lower jaw. They may arise in connection with the fang of a diseased tooth, or from suppuration of a dentigerous cyst. If the shell of bone surrounding the pus be very dense they may resemble solid tumours. Their treatment presents nothing peculiar.

Acute Suppurative Periostitis is occasionally met with in the lower jaw. It probably is dependent on carious teeth, but the immediate cause seems usually to be exposure to cold, such as riding in a train facing an open window. The disease is characterized by rapid swelling, with tension and redness of the skin. A large abscess quickly forms, surrounding the bone, usually limited to one side, about the angle. The swelling extends downwards into the neck, and tends to point externally. On opening the abscess a large part of the bone can be felt bare and denuded of its periosteum. If the pus be let out early, free drainage provided, and decomposition prevented, no necrosis may take place. It is usually necessary to make the incision externally, as the pus extends too far in the neck to allow of sufficient drainage being provided from within the mouth.

Necrosis of the Lower Jaw has been already described (p. 604).

Tumours of the Lower Jaw.—The lower jaw is a common seat of tumours. *Simple Epulis*, *Myeloid Sarcoma* of the alveolar border, *Epithelioma of the Gum* implicating the bone, and *Dentigerous Cysts*, have been already described with tumours of the alveolar borders and of the upper maxilla; they are, however, all more common in the lower jaw than in the upper.

Cysts of the Lower Jaw.—*Single cysts*, containing a glairy or mucous fluid in which cholesterine crystals are often seen, are not uncommon in the lower jaw. They cause a painless, slow enlargement of a limited portion of the bone. At first the fluid is surrounded by a solid bony wall, through which no fluctuation can be felt, and in this stage they have been mistaken for solid tumours. As the wall becomes thinner, fluctuation and egg-shell crackling can be felt. They originate in connection with a tooth, but their mode of origin is not very clear. Sometimes in extracting a painful tooth a small cyst, seldom more than a quarter of an inch in diameter, is found attached to a fang. These cysts are developed beneath the periosteum of the fang, and hence have been termed *periosteal cysts*. Tomes believes they are of inflammatory origin, and the fact that their contents have the appearance of inspissated pus bears out this view. Whether the single cysts are of a similar origin is not certain.

Multilocular-cysts, which have also been described under the names of cystic sarcoma, adenoma, and fibro-cystic tumours of the jaw, although occasionally met with in the upper jaw, are infinitely more common in the lower. These tumours are of slow growth, but may reach a great size; they are composed of cysts varying in size, and having more or less solid matter between them. The walls of the cysts are sometimes thin and membranous, sometimes composed of tissue appearing to the naked eye as fibrous tissue, while in other cases bony lamellæ enter largely into their composition, so that on pressure they occasionally communicate the semi-crepitant sensation peculiar to cystic expansions of osseous structures. The fluid contained in these cysts is viscid, and usually semi-transparent, yellowish or bloody. Most commonly these tumours run a simple course, but occasionally they have been known to recur after removal and infect surrounding parts. The origin of these cysts formed the subject of a most interesting lecture delivered by F. S. Eve at the Royal College of Surgeons. He confirmed the fact already noted by several observers that the solid part of these tumours is composed of irregular, branching columns of small round epithelial cells resembling those in the deeper layers of the epithelium of the gum, and surrounded by a fibrous stroma. In some cases the cells at the circumference were columnar. The cysts are formed by colloid degeneration of the epithelial cells. Eve believes that he has demonstrated that the columns of cells are formed by an ingrowth of the epithelium of the gum, and that the starting point of the disease is often the irritation caused by a diseased tooth. Falkson and Bryk on the contrary believe that in some cases at least these cysts have their origin in a persistence of a portion of the epithelium forming the enamel organ of the developing teeth. They found their opinion upon the resemblance of the epithelium cells and the contents of the smaller spaces to those observed in the enamel organ. The question of the origin of the tumours cannot be considered to be finally determined. That they are in some way connected with the teeth is highly probable, as they always start from the neighbourhood of the alveolar border.

Fibromata and Chondromata are met with in the lower jaw, and spring either from the periosteum or from the centre of the bone. They resemble similar growths elsewhere, and present nothing peculiar.

Osteomata of both forms, the cancellous and ivory exostosis, are met with in the lower jaw ; it is in fact one of the most common seats of the latter affection.

Odontoma.—This is not properly a tumour of the jaw, but it is most conveniently mentioned here, as closely simulating disease of the bone. An odontoma is the result of some peculiar modification in the growth of a tooth, resulting in the formation of an irregular mass of dental tissues of no definite shape. Tomes described one removed by Sir W. Fergusson as being " composed of enamel, dentine, and bone derived from calcification of remnants of the dentine pulp, thrown together without any definite arrangement." According to Heath only 8 cases have been recorded, all in the lower jaw. The tumour can be removed if its nature is recognized without taking away any of the jaw-bone. Outgrowths from the fangs of fully developed teeth composed of dentine and cement are not uncommon, forming the so-called warty teeth, but these are seldom of sufficient size to be of any surgical interest.

Sarcomata of various kinds form a considerable proportion of tumours of the lower jaw. Myeloid, spindle-celled, and round-celled sarcomata are all met with. The first is always central, the two last may be periosteal or central. Chondrifying or ossifying sarcomata are occasionally met with. The myeloid tumour usually runs a simple course, the other forms are frequently malignant. The mode of growth of these tumours and the symptoms they give rise to are the same as in other parts.

Diagnosis.—In the lower, as in the upper jaw, it is of great importance to diagnose the simple from the malignant affections ; as in the latter form of disease an operation is sometimes not advisable, the soft tissues around the bone being implicated to such an extent as not to admit of removal, and consequently not of the full and complete extirpation of the disease. The malignant tumours may generally be readily detected by the rapidity of their growth, by their pulpy or elastic character, and by infiltration of neighbouring parts, with early adhesion to the skin and occasionally by their implicating the glands below the jaw.

Treatment.—The treatment of tumours in the lower jaw depends in a great measure upon the character of the growth. In single cysts of moderate size, with thin walls and but little solid tissue around the cysts, the best mode of treatment consists in cutting down through the gum on the expanded portion of bone, opening the cyst by means of the antrum-perforator, small trephine, or cutting pliers, according to its size and the thickness of its walls; letting out the contained fluid; and then, by introducing a plug of lint, causing the cavity to granulate from the bottom, and gradually to contract. When the cysts are so large that they have destroyed the integrity of the bone, or when they are associated with a large quantity of solid tissue, as in the true multilocular cysts, excision of the diseased bone must be practised. This, also, is the only plan of treatment that can be had recourse to in other growths in this bone.

Excision of the Lower Jaw.—The operation of excision of a portion of the lower jaw for tumour of that bone was first performed by Deadrick of Tennessee, in 1810, and not as is generally but erroneously supposed, by Dupuytren. As the growths for which this operation is performed are usually situated between the symphysis and the angle of the bone, seldom extending beyond the middle line, the operation is generally limited to one side of the face. In some instances, however, the tumour may encroach so far that it may be necessary to remove more than the half of the bone; and in other cases again, though of very rare occurrence, the whole of the bone has been disarticulated.

When the tumour is of moderate size, and is situated about *midway between the symphysis and angle* of the jaw, it may be reached by making a semilunar incision of sufficient length under the lower edge of the bone, and carrying the anterior extremity of it well forward upon the chin, but not dividing the lower lip, if it can be avoided, nor cutting into the angle of the mouth; then dissecting up the flap thus formed, and carrying the knife cautiously along the inner side of the jaw, so as to detach the mucous membrane of the mouth and the mylo-hyoid muscle to a sufficient extent. In doing this, the hæmorrhage is often very profuse: the bleeding from the facial artery is particularly forcible, the blood being thrown in a larger and stronger jet than would seem possible from the size of the vessel. The hæmorrhage should be at once controlled by the application of ligatures to both ends of the bleeding artery, and to any other points from which it is abundant. Unless this be done, the after-steps of the operation will be rendered much more obscure and difficult. One of the teeth on each side of the tumour having been previously drawn, the jaw must now be deeply notched through their alveoli into its base with a narrow strong-backed saw, and cut through with pliers, or completely divided with the saw. After the fragment of diseased bone, with the attached tumour, has been removed, and all bleeding vessels have been secured, the flap of cheek should be laid down smoothly, and retained *in situ* by means of hare-lip pins. Occasionally the dental artery in the cut jaw gives trouble; the hæmorrhage from this source may be checked by the application of a piece of solid perchloride of iron, or by touching it with the actual cautery. The patient must at first be fed with slops, which should be sucked in through a tube. At a later period, when cicatrization is well advanced, the teeth should be tied together with strong silver wire; or a silver cap should be fitted upon the teeth of the two portions of bone that are left, and attached by an elastic spring to another silver cap put on those of the upper jaw, so to prevent the displacement that would otherwise occur in the smaller fragment. Union takes place after a time by fibrous tissue, which becomes sufficiently dense to make the jaw strong and useful.

In those cases in which the tumour *encroaches upon the angle and ramus* of the jaw, it is usually better to remove the bone at the articulation on the affected side ; for, if the articular end including the coronoid process be left, it will be displaced forwards and upwards by the action of the temporal and external pterygoid muscles, and be a source of much inconvenience and irritation to the patient, not compensated by any corresponding utility. In these cases, the removal of one lateral half of the jaw will consequently be required, and the operation may be performed in the following way. The patient's head must be allowed to fall a little backwards so that the chin may be well raised from the chest. An incision is then made, commencing near the symphysis, passing along the under surface of the body of the jaw as far as the angle and then upwards at the posterior border of the ramus as far as the level of the lobule of the ear. If the tumour be very large it may be necessary to make an incision upwards towards the lip from the anterior end of that just mentioned or even to divide the lip completely, but this should be avoided if possible. The facial artery and vein are wounded in the first incision and must be at once secured. The flap is then raised and the mucous membrane divided along its reflexion from the cheek. If the tumour is simple this may be partly done with a periosteal elevator, the periosteum being saved where it can be safely taken from over the tumour. The knife is then carried behind the jaw in front of the tumour separating the mylo-hyoid and dividing the mucous membrane in the floor of the mouth, care being taken not to cut

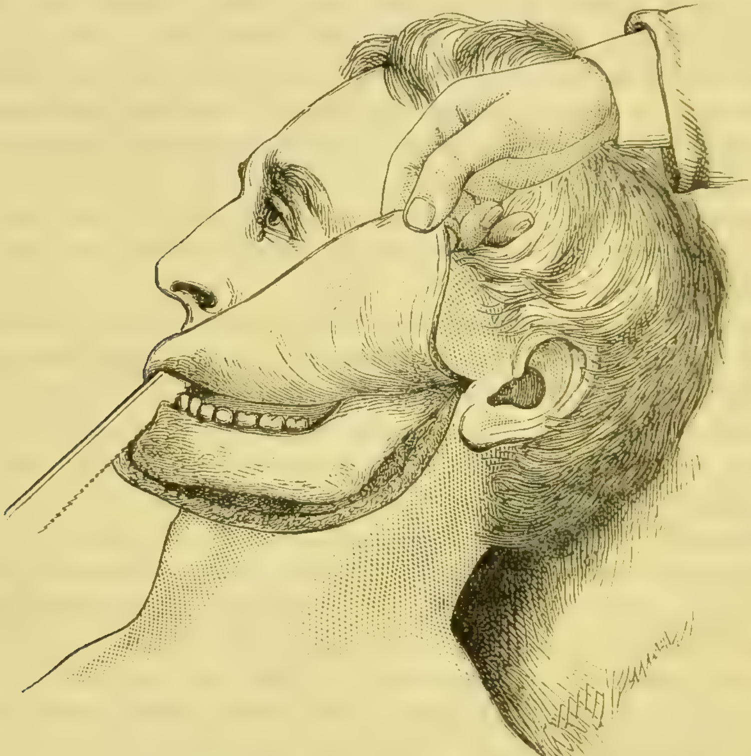


Fig. 697.—Excision of Lower Jaw. Soft parts raised.

away the genio-hyoid and genio-hyoglossus muscles, unless the situation of the tumour is such that this cannot be avoided. If these muscles are necessarily divided, a thick ligature should be passed through the end of the tongue, which must be drawn forwards by an assistant, lest it fall backwards into the pharynx and thus threaten or even occasion suffocation, as has happened to Surgeons of eminence both in France and in America. The jaw having been cleared on both sides in front of the tumour, the incisor tooth must be drawn at the point where it is intended to divide the bone, and the saw (Fig. 697) applied. The section should be completed with the saw, as if the bone forceps be used a jagged edge will probably be left. The jaw is then seized either by the fingers or in the lion-forceps, and forcibly depressed and drawn somewhat outwards, while the cheek flap is pulled upwards so as to bring the coronoid process into view with the attachment of the temporal muscle, which must be divided. If, as sometimes happens, this cannot be easily reached, the coronoid process may be cut through with a saw and removed afterwards. As soon as the bone is freed from the temporal muscle it may be drawn more outwards and its inner side cleared from the internal pterygoid, care being taken to keep the edge of the knife turned towards the bone to avoid the submaxillary gland and the lingual nerve. Lastly, by forcibly depressing the bone the condyle is dislocated ; the external pterygoid is divided by a touch of the knife, and the bone then comes away (Fig. 698). During this stage of the operation care must be taken not to divide the internal maxillary artery, which lies close to the neck of the bone between it and the internal lateral ligament. If the bone be twisted too much outwards the condyle will pass under the artery, which is then torn through or cut. Should the artery be divided, it must be ligatured, or if it be cut very close

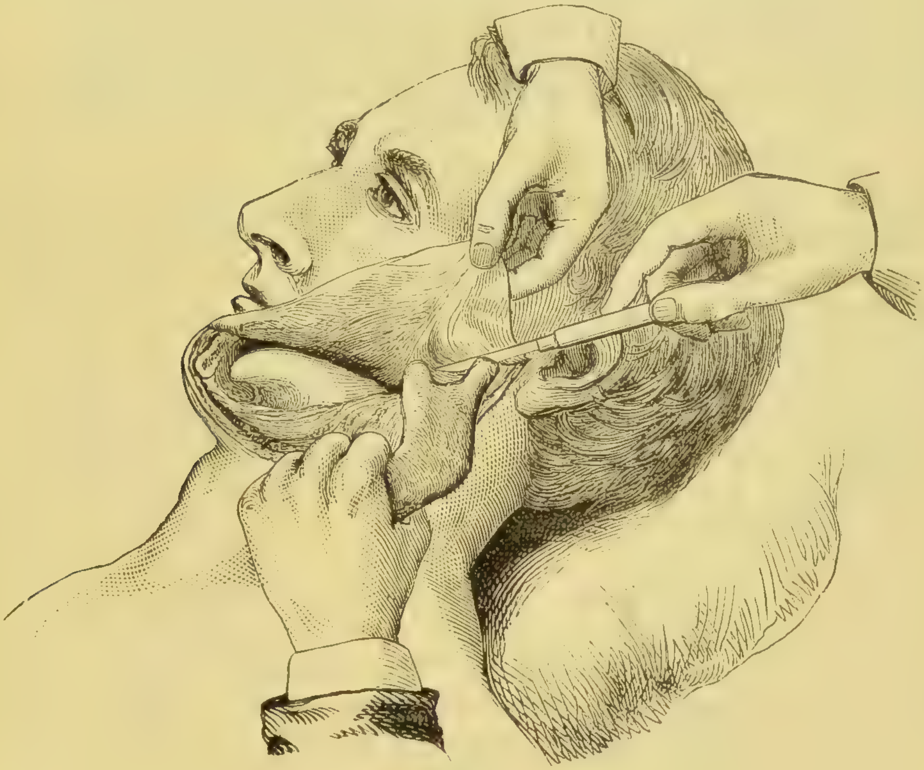


Fig. 698.—Excision of Lower Jaw. Disarticulation of Condyle.

to the main trunk it may be necessary to tie that immediately below the point at which it divides into the temporal and internal maxillary. In depressing the bone to reach the temporal muscle and the joint, care must be taken not to use too much force, lest it happen that the ramus give way, having been weakened by the disease ; this accident causes a good deal of difficulty in disarticulation, which can be accomplished only by seizing the fragment left behind in necrosis-forceps, thus dragging it forwards and then dividing the muscle and capsule. When the operation is completed the raw surface should be touched with a solution of chloride of zinc and sprinkled with iodoform. The flap is then brought down and secured with sutures, a drainage-tube being inserted at the lower and posterior angle of the wound. If the symphysis have been removed the root of the tongue must be stitched forwards and the ligature through its tip must be retained for a few days till all danger of its falling backwards into the pharynx is past, so that it may be drawn forward if necessity arises. When cicatrization is complete a dense mass of fibrous tissue is formed in the place of the jaw, and comparatively little deformity results.

DISEASES OF THE TEMPORO-MAXILLARY ARTICULATION.—The articulation of the jaw, though less frequently diseased than most other joints, is liable to the same affections as similar parts elsewhere. **Chronic Rheumatic Arthritis** of the temporo-maxillary articulation has been already described (p. 357). **Acute Arthritis,** terminating in destruction of the joint and fibrous or osseous ankylosis, most commonly occurs in consequence of disease of the middle ear in scarlet fever. According to A. E. Barker, who has specially called attention to this form of disease, it is met with almost exclusively in children, and is due to the persistence of a hiatus in that part of the tympanic plate forming the floor of the meatus and the roof of the articulation. This hiatus is always present in infancy, and may remain in adult life. The disease may result also from necrosis of the bone in chronic suppurative inflammation of the middle ear after fevers. The symptoms are those met with in other joints—acute pain, redness, swelling, and the formation of abscesses discharging either on the cheek or by the ear. The treatment consists in rest and opening the abscesses. **Ankylosis of the Jaw** may be fibrous or osseous. It necessarily, even if affecting one side only, prevents mastication. If fibrous, it may be treated by forcibly opening the mouth under chloroform by means of a screw-gag, or of an apparatus specially constructed for the purpose, after which a wedge may be placed between the teeth to keep them apart. This treatment is painful, and has to be repeated at intervals for some time, lest the articulation become again stiffened. It is not usually very satisfactory. Spanton has succeeded in producing a better result by dividing the fibrous bands in the articulation by means of a tenotome passed into it. In firm fibrous ankylosis in which other means have failed, or in osseous ankylosis, the only treatment likely to be followed by good results is excision of the condyle of the jaw. This is best done by an incision carried along the lower border of the zygoma from immediately in front of the ear, avoiding the temporal artery, to the malar bone. From the middle of this a short vertical incision may be carried downwards, for about three-quarters of an inch, dividing the skin and fat only. The masseter is then separated from the zygomatic arch, as far as it is exposed, by the scalpel and periosteal elevator. The neck of the bone is thus fully exposed, and must be carefully cleaned with a narrow elevator, keeping close to the bone so as to avoid injuring the facial nerve or internal maxillary artery. The neck of the bone is then divided with a narrow chisel. After this, if the ankylosis is fibrous, it may be possible to lever the condyle out with an elevator; if it is osseous, a second section of the bone must be made with the chisel immediately below the zygoma. This operation has been successfully performed by Davies-Colley, C. Heath, and others. The result is usually very satisfactory. Humphry, of Cambridge, also successfully removed the condyle in 1856 for rheumatoid arthritis.

J. E. Mears, of Philadelphia, has successfully operated on four cases from within the mouth. He first passes a sharp bistoury between the masseter and the bone at the level of the last molar tooth, and then saws through the ramus at that point. The soft parts are then separated from the bone above the section by a periosteal elevator, and the insertion of the temporal muscle divided with a probe-pointed bistoury. The bone is then seized in the lion forceps and an attempt made to wrench it out. If the ankylosis is bony, the neck probably fractures, and is then smoothed down, and as much as may be necessary removed by a chisel. Hæmorrhage is arrested by pressure. The internal maxillary artery is avoided by keeping the instruments close to the bone, but the inferior dental nerve and artery are necessarily divided. The facial nerve on the other hand is not in danger, nor is there any external scar. The results of his cases were most satisfactory.

Enlargement of the Condyle of the Jaw is a rare condition occasionally met with. There is great and irregular increase in size of the condyle, apparently due to the formation of ossifying cartilaginous outgrowths similar to those of rheumatoid arthritis. In a case of this kind recorded by Adams, other joints were similarly affected. In two other cases recorded by McCarthy and C. Heath, there were no signs of general articular affection. In Heath's case the chin was thrown over to the opposite side, and great deformity resulted. The diseased condyle was successfully removed. It measured one inch and three-quarters from before back and one inch across. The improvement in the appearance and in the utility of the jaw was very marked.

Spasmodic Closure of the Jaws.—*Spasmodic closure* of the jaws, lasting weeks or months, and often accompanied by considerable pain, is not an uncommon result of retention of the wisdom tooth, either from faulty position, or from the second molar not allowing room for it to reach the surface. It occurs between the ages of 20 and 35, at the period at which the wisdom tooth should be cut. Chloroform must be administered, and the mouth gagged open. The second molar must then be extracted to give room for the wisdom tooth, after which the symptoms soon subside.

Permanent Closure of the Jaws may be due to ankylosis of the joint, as already described. It is perhaps, however, more commonly the result of contraction of cicatrices, resulting from cancrum oris, or from gangrenous stomatitis following the excessive administration of mercury, or more rarely from extensive necrosis. When the mucous membrane has been destroyed by ulceration from the one alveolar border to the other, the resulting cicatrix binds the jaws so firmly together, that not only is movement impossible, but the inside of the cheek is in such close contact with the teeth, that there is scarcely room to pass a director between them. Under these circumstances it is evident that little can be done to relieve the patient from within the mouth. Division of the cicatrix followed by forcible extension has been recommended and practised, but never with any good result. As the raw surface heals, the contraction necessarily recurs, and the last state of the patient is much the same as the first. Mears, however, states that contraction is less likely to recur if the bands are slowly divided by means of a ligature passed round them from within the mouth. If the band were very narrow, and healthy mucous membrane existed on each side, which could be drawn in by contraction of the sore in healing while the mouth was gagged open, some benefit might result, but practically such a condition is never met with. Various attempts at plastic operations, similar to those performed for faulty cicatrices in the skin, have been suggested and attempted, but no good result has been obtained. In order to relieve this distressing deformity, Esmarch, of Kiel, in 1855, suggested division of the jaw and the formation of a false joint in front of the cicatricial bands. About the same time, Rizzoli, of Bologna, made a similar suggestion. In Rizzoli's method the jaw is simply divided from within the mouth by a pair of strong cutting pliers ; in Esmarch's operation a wedge-shaped piece of bone with the apex towards the alveolar border is removed by a saw from an incision made from outside at the lower border of the jaw. The performance of the operation is sufficiently easy, but considerable difficulty is found in maintaining the movement between the fragments after cicatrization is complete. The tendency to re-union by bone, or by fibrous tissue so dense as to prevent all movement, is certainly less when a considerable piece of the jaw is removed. C. Heath, who was one of the first to perform the operation in this country, expresses a strong preference for Esmarch's operation. In one case operated on by him by this method in 1864, the patient was found to have good use of the sound side of the jaw in 1880. The wedge of bone removed measured seven-eighths of an inch at the lower border.

CHAPTER LVII.

PLASTIC SURGERY OF THE FACE AND MOUTH.

By **Plastic** or **Reparative Surgery** is meant the performance of operations for the repair of deficiencies in structure, whether resulting from injury, from disease, or from malformation.

It has been long known that portions of the body may retain sufficient vitality to become again adherent, when attached only by a very narrow tongue of tissue to the part from which they have been all but separated. This has often been observed in injuries of the face and fingers, portions of which have been almost completely severed, and yet have united again on being replaced. But there is a sufficient number of cases on record to show that certain parts, when completely separated, may, after being replaced, again become adherent. The most remarkable instances of this kind are those which are related by Hoffacher, and attested by Chelius and Velpeau. Hoffacher was officially appointed to attend as Surgeon at the duels which were then, as now, frequent amongst the students at Heidelberg ; and, as at these encounters swords were used, he had an opportunity of seeing a considerable number of incised wounds, and has related no fewer than sixteen cases in which portions of the nose, lips, or chin had been sliced off, and, being put on again, contracted adhesions. Amongst the most remarkable of these, is one in which the end of the nose was sliced off, and fell under a chest of drawers ; it was not found for some time, but, on being recovered and washed, was stitched on, and became firmly attached. In another instance, a dog that was in the room snapped up the detached portion of the organ as it fell to the ground, but the nose, being immediately taken out of the animal's mouth and put on again, became firmly fixed.

In order that union should take place between parts that have been separated completely or nearly so, and the rest of the body, it is necessary that they be soft and vascular, and more especially that their structure be of a homogeneous character such as is met with in the tissues of the face, where no very large blood-vessels, nerves, tendons, or bones are found. It is the same in plastic operations, which succeed best under similar conditions of tissue, and which are conducted on the same principle as an attempt at union in a partially severed structure.

It is principally for deformities and loss of the nose and lip that plastic operations are of much service ; they may, however, occasionally be had recourse to in other situations, as about the cheeks and eyelids. Reference has already been made (Vol. I., p. 898) to the performance of plastic operations on the perinæum. In the practice of this very interesting branch of surgery, there is much opportunity for the display of manual dexterity. On this, indeed, almost the whole success of the operation depends ; and a vast deal may be done in apparently the most unpromising cases by skill and patience. In these operative procedures the names of Serres, Dieffenbach, Liston, Syme, Fergusson, Sédillot, B. Langenbeck, Jobert, and Wolfe, deservedly take the first rank.

In performing the various plastic operations five methods have been employed. In the first, the flap of the skin that is intended to repair the lost structure is transplanted from a distant part, as the arm. This operation, introduced by the Italian Surgeon, Tagliacotius, in the sixteenth century, and hence commonly called by his name, has in a great measure fallen into disuse, on account of the difficulty of its execution, and the great uncertainty of obtaining a successful result. The second plan, which was first practised by G. Lawson and subsequently by Wolfe, of Glasgow, consists in the transplantation of a piece of skin of considerable size from one part of the body to another, the transplanted portion being completely separated at the time of the operation, and carefully freed from every trace of subcutaneous fat with a pair of sharp flat scissors. The third plan consists in transplanting the reparative structure from some part in the neighbourhood of the organ to be repaired; the skin from the forehead, for instance, being used for the formation of a new nose; that from the chin for the restoration of a lost lip. This procedure, which seems first to have been adopted by the natives of India in restoring the loss of the nose, is the method that is most commonly employed in this country in plastic operations on the face. The fourth method consists in loosening the skin by a process of subcutaneous section to some distance around the part to be repaired, and then drawing it forwards with or without incision through its substance. This gliding operation is chiefly practised for the closure of fistulous openings. The fifth method is employed in cases where an abnormal fissure exists in a part. It consists in bringing together and uniting the edges of the fissure, after having pared them evenly, so as to expose their vascular surfaces.

Union in plastic operations should take place by the first intention. Should this, however, fail, the Surgeon need not despair; as the parts may unite by granulation, in a very satisfactory and complete manner.

For proper union to be obtained, it is necessary that the edges be clearly and evenly cut, so as to adjust themselves accurately to one another. This may often be best effected by making the incision in the part that is to receive the flap somewhat bevelled, thus securing a more accurate adaptation of the edges. After the flap has been formed and the part in which it is to be transplanted properly pared, the operation should be delayed a few minutes until all bleeding has ceased. This is of much importance, as the interposition of a layer of coagulated blood will materially interfere with union. In bringing the parts into apposition, great care must be taken that no undue traction be exercised, lest their circulation be interfered with, and their vitality be endangered. The parts may be maintained in apposition by sutures, collodion, or a strip of isinglass plaster. The sutures should be as fine as possible, introduced with a small needle, and knotted on the sound parts. Horse-hair, fine catgut or silkworm-gut will be found the best materials where there is no strain on the sutures; should there unavoidably be some strain a deep metallic stitch should be passed to relieve the finer sutures. Occasionally hare-lip pins may advantageously be used. The use of collodion, where applicable, is of great advantage, as it not only secures adhesion, but, by excluding the air, lessens the chance of suppuration. If the wound is large, it must not be completely covered by collodion lest discharges accumulate beneath the flap. In some parts in which the wound is moistened by the secretion of some neighbouring mucous membrane and cannot be kept dry, as in the eyelids, wet boracic acid lint or boracic acid ointment will be found the best application; in other parts absorbent iodoform or salicylic wool may be applied, a small piece of the "protective" oil-silk being placed next the wound to prevent it from sticking. The wool may be fixed in position by collodion.

For a plastic procedure to succeed, it is necessary that no morbid process be going on in the seat of operation; and not only that none be actually in progress, but that all have ceased for some considerable time. This is more particularly the case when the deformity has resulted from strumous or syphilitic ulceration. In such cases it is necessary to see that the constitution is sound, as well as that all local disease has been eradicated; otherwise the irritation of the operation might set it up again, and the new flap might be invaded and destroyed. From want of this precaution, I have more than once seen disappointment result. When an operation, as on the nose or lip, is performed for epithelioma or rodent ulcer, ablation of the morbid part and the plastic operation may be done at the same time—the affection being a local one. As a general rule, plastic operations practised for the repair of mutilations from injury or of congenital deficiencies, are more successful than those that are performed after disease.

No routine system of treatment should be adopted; but a few days of rest, good diet, and a dose or two of aperient medicine, may be prescribed before the operation is proceeded with. In the after-treatment of the case, a nourishing but unstimulating regimen should be observed.

Faulty Cicatrices about the face and neck often occasion much deformity and annoyance, and may require a plastic operation for their removal. Those resulting from burns have already been considered, as also their treatment (Vol. I., p. 393 *et seq.*) When due to other causes, such as the unskilful opening of strumous abscesses, or the healing of wounds with dirt or grains of gunpowder imbedded in them, being puckered, depressed, adherent, or discoloured, much may be done by proper surgical means to remove the disfigurement they occasion. This is best done by dissecting them out cleanly, then loosening the edges of the cut by running the point of the scalpel under the skin, so that they may be brought together without puckering, and then uniting them by means of horse-hair or fine catgut sutures passed by a round sewing-needle.

Burow's Operation.—A plastic operation specially suited for the repair of deformity consequent on the removal of morbid growths from the cheeks and other parts of the face, has been introduced by Burow, a Polish Surgeon, and successfully performed by Stokes (Fig. 699). The steps are as follows. The growth to be removed is included in three incisions, 1, 2, 3; and the integuments from which it springs are then carefully dissected off, leaving a raw triangle, the apex of which is on one, the base on the other side of the tumour. The incision 1, 4, 3, is then carried outwards to 5, 8, 7, so that the whole distance from 1 to 7 is exactly three times that of the base of the raw surface; a second triangle, 5, 6, 7, is then made, having its base on the outer third of this horizontal incision. The two triangles must be of equal size, and the integuments are dissected off 5, 6, 7. There are thus two raw surfaces to be covered in. This is done by dissecting up carefully the flaps 1, 5, 6, and 2, 3, 7. When this is done, the points 1 and 3, and 5 and

7, are respectively drawn together, each by one suture, and the two raw triangular surfaces are thus covered in.

Plastic operations of various kinds are frequently performed on the eyelids.

Blepharoplasty, or the operation by which the eyelids are repaired, is occasionally required for loss of substance—the result of wounds, cicatrices, or operations. It is less satisfactory in its results than most of the other plastic procedures about the face ; yet it may, in some cases, materially improve the patient's appearance.

When the upper eyelid requires repair, the flap is taken from the forehead ; when it is the lower lid, from the cheek or temple. This operation may be performed by the gliding method, by twisting a flap into its new situation, or by transplantation of a piece of skin. By the gliding method, a triangular flap is cut and partially detached (Fig. 700, *a*), and then drawn gently forwards until it corresponds to and fills up the gap that requires repair, when it is there fixed by a few points of suture. When the twisting method is employed, an oval flap is detached (Fig. 700, *b*), except its pedicle, and twisted down, to be planted on the raw surface.

Occasionally neither of these methods is applicable ; and then the procedure that I successfully adopted in a case of which the annexed cut (Fig. 701) is a representation, may be followed. In this case, which was that of a lady who had received a severe mutilation of the face by the explosion of a ginger-beer bottle, there was a deep and hard cicatrix across the lower eyelid, causing depression and eversion of its outer portion, and adhesion of the inner part to the ball of the eye. After dividing the adhesions and removing the cicatrix, I made a semilunar incision so as to dissect up the eyelid, and then fixed it by points of suture in its new situation, when it became firmly adherent (Fig. 702), and scarce any apparent deformity was left. In another very similar case, in which a girl had been bitten through the lower eyelid by a dog, a similar operation was practised with equally good results. In both these cases, the eyeball, having been injured, had become atrophied, with opacity of the cornea. But, when an artificial eye was adjusted to the shrunken globe, the appearance of the patient was most satisfactory.

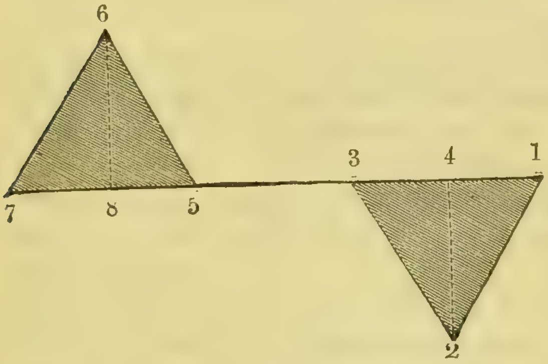


Fig. 699.—Lines of Incision in Burow's Operation.

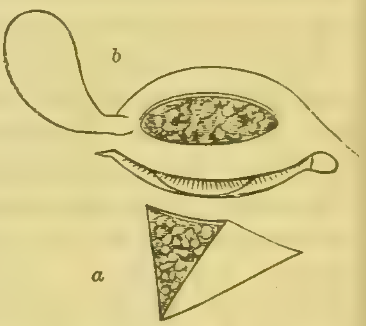


Fig. 700.—Operation for Repair of Eye-lid : (*a*) Gliding Method : (*b*) Twisting Method.

Restoration of the lower eyelid in extreme ectropion by complete transplantation of a piece of skin was first performed by G. Lawson in 1870, and afterwards by Wolfe of Glasgow in 1875, since which time it has been repeatedly performed with success. The operation is thus performed : the eyelid is first freed from the abnormal situation into which it has been drawn until its free border can be brought in contact with the upper lid, the two lids then being tied together by sutures passed through them. An accurate pattern of the raw surface to be covered is then taken, and a flap of skin is raised from the forearm corresponding in shape but a little larger to allow for shrinking. The under surface of the flap is then freed from every vestige of subcutaneous tissue with a pair of flat sharp scissors, so as to have a white appearance. It is then applied to the raw surface and united to the surrounding skin by fine silk sutures. A dressing of warm wet boracic acid lint may then be applied and covered by gutta-percha tissue and cotton-wool. About a fortnight after the operation, after the flap has become firmly adherent, the sutures uniting the lids may be removed and the eye allowed to open. In a case successfully operated on by Wolfe, the oval piece of skin transplanted measured two inches by one and a quarter. It united by first intention, without even desquamation of the cuticle taking place.

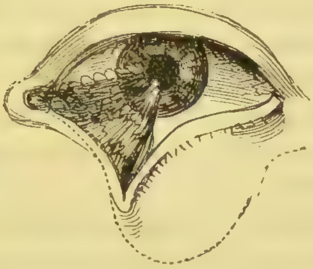


Fig. 701.—Lower Eyelid deformed by Cicatrix.

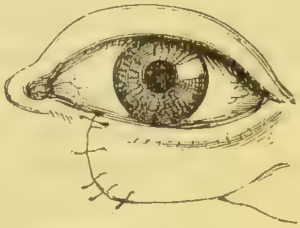


Fig. 702.—Lower Eyelid after Operation.

PLASTIC SURGERY OF THE NOSE.

Rhinoplastic Operations are undertaken for the restoration of a part of the nose, which has been destroyed by injury or disease. This branch of plastic surgery has long received much attention, and has been reduced to distinct rules. Either the entire nose, or a portion of it, may require restoration.

Columna.—When the columna and a portion of the septum are destroyed, a large gap is left at the nasal aperture ; and, the nose becoming flattened in consequence of its tip falling in, great deformity necessarily results. The upper lip also, losing that amount of support which it receives from the columna, becomes pendulous, projecting, and thickened, thus adding to the disfigurement. The restoration of the columna is effected from this thickened and prominent upper lip, which, by being reduced in size, is rendered more shapely. The operation consists in cutting through the whole lip from above downwards on each side of the mesial line, so as to leave a tongue about one-third of an inch in width. This is then turned up ; and its free end being well pared, and the under surface of the tip of the nose properly freshened, it is fixed by means of a fine hare-lip pin and twisted suture, which should be left in for about four days. Union takes place in a few days ; but until this is firm, the new columna must be properly supported with narrow strips of plaster fixed to the cheek on each side. No twisting of this small flap is required, as the mucous surface speedily becomes cutaneous, and *vice versâ*. The division in the upper lip must be treated in the same way as an ordinary hare-lip, and unites without difficulty, lessening greatly the deformity in this part.

Ala.—When one ala only is deficient, the rest of the nose being sound, one of three processes may be adopted to remedy the deformity. 1. When a small portion only of the free border of the tip has been lost, an incision should be made (Fig. 703) across the nose, and the remains of the ala and a portion of the nasal integument thus marked out dissected down, and attached to the end of the organ. In this way a very excellent result may be obtained.

If the loss of substance be greater, a flap of skin, of the proper shape, may be raised from the cheek, applied to the previously pared edges of the part requiring it, and fixed there by a few points of fine suture.

If the loss of the substance of the ala be very considerable, or if it extend to a part of the body of the nose, other plans, to be presently described, are required for the repair of the deformity.

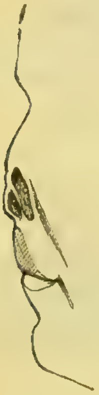


Fig. 703.—Deficiency of Ala of Nose.

Entire Nose.—For the restoration of the entire nose, two procedures have been employed: viz., 1, the Tagliacotian Operation; 2, the Indian Operation.

1. The **Tagliacotian Operation** consists in taking the integument and areolar tissue required for the repair of the lost organ from the inside of the arm. Here a flap of sufficient extent is to be marked out and dissected up with its subjacent areolar tissue, leaving it merely attached to the limb by a root at its distal end. Some Surgeons attach the flap at once to the raw surface, but others recommend that this should not be done for at least a fortnight, during which time it should be kept upon a piece of wet lint, and allowed to thicken and granulate. The remains of the deformed nose having then been properly pared and the flap shaped, they must, after all bleeding has ceased, be properly adjusted and fixed to one another by points of suture. The arm must then be closely attached to the head, so as to be as nearly as possible immovable. At the end of about ten days, when adhesions have taken place, the connecting medium may be cut across, and the part left to be supported by the vitality which it may gain from the new surface to which it is now attached. This process is comparatively seldom had recourse to, for obvious reasons. The uncertainty of maintaining the vitality in the flap, the extreme tediousness of the prolonged constrained position in which it is necessary to keep the patient, and the great difficulty of guarding against movements of the arm, especially during sleep, and which, however slight and involuntary, would be sufficient to disturb union between the opposed surfaces, and occasion the failure of the operation, have caused this plan of procedure to fall into disuse, and it is now, I believe, universally abandoned.

2. The **Indian Operation**, a knowledge of which was brought to this country by Carpue in 1814, is extremely successful in its results, though requiring a good deal of nicety for its proper execution. The operative procedures required by this method may conveniently be divided into three stages: 1, the Dissection of the Flap from the Forehead, and its Attachment to its new situation; 2, the Separation of the Root of the Flap where it is turned down from the Forehead, and the Formation of a proper Bridge to the Nose; 3, the Formation of the Columna Nasi.

1. **Formation and Attachment of the Flap.**—In the shaping of the flap, care must be taken that it is of sufficient size; as during the after-part of the treatment it often has a tendency to shrink. The size adapted to the particular face may best be judged of by moulding a thin piece of gutta-percha to the nose, then flattening it out by dipping it in hot water, and using this as the guide for marking the outline of the flap upon the forehead. This should be traced with tincture of iodine, which will not be washed off so readily as ink by the flow of blood, which is often rather free. This flap should be of the shape shown in Fig. 704, care being taken that it is rather square at the angles, and not too much rounded off. The size will necessarily vary according to the extent of loss that has to be repaired. When the whole of the nose requires restoration, it is usually necessary to make it about two and a half to three inches in length, by about the same in width at the broadest part. It may either be taken from the middle of the forehead, or obliquely from one side; if the latter, the right side is the most convenient. It must now be dissected off the forehead; in doing this, care must be taken to cut the flap as thick as possible, especially at its root between the eyebrows. It must also be but little handled, and above all, not pinched, either with fingers or forceps. The dissection should be commenced at the root, so that the outline may not be obscured by blood; and this part should be left long, in order to admit afterwards of a very gradual and easy twist. In order to facilitate this, it is desirable also to make the incision on the right side a little lower than that on the left. After the flap has been raised throughout the whole of its extent, pressure should be applied to the forehead by means of a sponge, with a view of arresting the bleeding, before the next step is taken. This consists in paring the surface and edges of the stump of the nose, and removing the integuments from it in such a way as to leave a triangular raw surface. In doing this care must be taken—whilst a good base of attachment is left—not to remove the parts too widely, lest the cheeks should retract, and flatten out the nose. The integuments also should be dissected away in such a manner as to form a deep groove shelving inwards, so as to receive and hold the flap more securely and with less overlapping of the edges. The operation must now be discontinued until all bleeding has ceased, and the cut surfaces have become glazed; this point is of great importance in securing direct adhesion. The bleeding having been arrested by exposure to the air, and by the torsion rather than the ligature of any spouting branch, the flap from the forehead should be brought down by a twist from left to right, and attached by a few points of fine suture on each side to the edge of the incision, around the nasal aperture. A pledget of soft lint, or wool greased with carbolic oil, should now be gently insinuated under the flap, the lower part of the incision in the forehead drawn together by a point of suture, but not so as to constrict the root, and the rest of the exposed surface covered with some simple dressing.

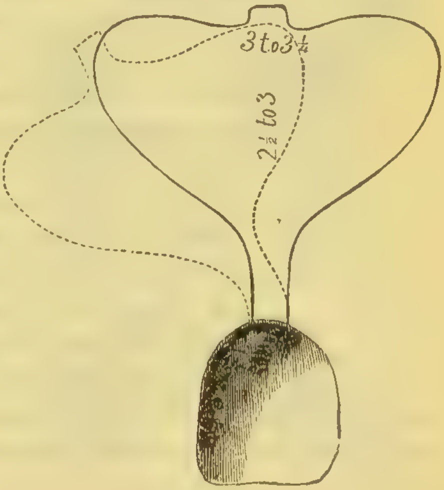


Fig. 704.—Diagram of Flap in Rhinoplastic Operation.

The parts will then present the appearance of Fig. 706, taken from a patient of mine the day after the operation. Fig. 705 represents the deformity for which the operation was performed. The patient should be put to bed with a piece of cotton-wool laid over the whole of the face, so as to maintain its temperature ; and, if it be winter, he must be placed in a room that is well warmed day and night.

The dressings must not be disturbed for three days : by this time, if all go well, the flap will be found somewhat tumid, warm, and sensitive, but pale in colour. The plug in the nose will now require changing, lest it be rendered offensive by the discharges; its withdrawal and the substitution of another must be done with the greatest gentleness, lest the adhesion of the flap be broken down. If the sutures produce no irritation, they may be left in till the fifth or sixth day, by which time adhesion will be tolerably perfect, and they may with safety be cut and withdrawn. As adhesion strengthens and the vitality of the flap improves, it must be elevated by putting underneath it a larger plug of lint ; for which, after a time, may be substituted a small gutta-percha tube moulded to the figure of the inside of the nose. Œdema of a somewhat solid character is apt to come on in the flap, giving it a white appearance ; but this is of little moment, and will gradually subside as the circulation through it becomes more actively established. The flap gradually becomes thicker and firmer, throwing out granulations from its under surface, which eventually becomes covered by epithelium. The wound on the forehead must be dressed like an ordinary ulcer. It usually cicatrizes with great readiness, and leaves a remarkably small scar.

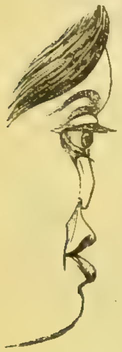


Fig. 705.
Depressed Nose.

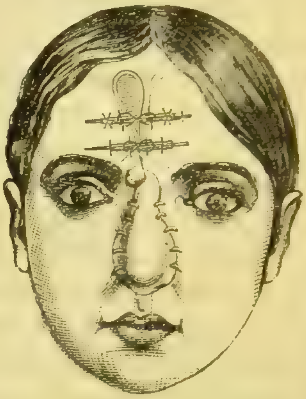


Fig. 706.—New Nose, day after Operation.

2. **Separation of the Root of the Flap.**—This may be done about a month after the flap has been fashioned, when its vascularity, through its lateral adhesions, will be perfected. The division of the root is best done by passing a narrow-bladed bistoury under the twist, and cutting upwards towards the eyebrows, removing a wedge-shaped portion of the soft parts, so as to make a smooth and proper bridge.

3. **Formation of the Columna Nasi.**—The addition of the columna is now all that is wanted to make the nose complete. This must be made from the upper lip, perhaps at the same time when the bridge is fashioned ; and it may be cut and fixed in the way that has been already described in speaking of the restoration of this feature, the interior of the apex of the new nose having been well pared to receive it. The columna must be well supported by means of a narrow strip of plaster passing from one cheek to the other, and usually requires a good deal of fashioning before it is perfect ; indeed, this is the part of the operation that I have found always most troublesome, and requiring most attention.

The new nose must continue to be supported from beneath, for some months after its formation, by plugs of lint or small gutta-percha tubes, as it will evince a great tendency to contract and to alter in its general outline and shape ; becoming, if the Surgeon be not careful, either depressed or dumpy. The sensibility of the new nose is entirely destroyed for a time after the division of the bridge ; but this slowly returns from all sides, appearing first in the neighbourhood of the adhesions between it and the cheeks, then near the columna, next in the bridge, and thus the organ at last has its sensation restored ; for this, however, several months will usually be required, and the part in which it returns last of all is its central portion.

The annexed cuts (Figs. 707, 708) give a very faithful representation of a patient on whom I operated, before and after the restoration of the lost organ.

The success of the case will depend very greatly upon the minute attention which the Surgeon bestows on the details of the operation, and on the care which he takes in the after-treatment. During the operation, the chief points to be attended to are, that the flap be made of sufficient size, that all oozing have ceased before the cut edges are brought into contact, and that no tension or constriction be exercised. A principal source of failure in the operation, or in the result so far as concerns the after-appearance of the patient, is gangrene of the flap, in whole or in part, arising from the root being too narrow or too tightly twisted, or from the flap being too roughly handled in its dissection. So also, if it be cut too small and not properly supported afterwards, the result will not be very satisfactory. Other accidents occasionally happen ; thus, erysipelas may occur early, destroying the vitality of the flap, or come on at a later period, causing the new nose to slough under the attack of inflammation, which it has not sufficient vitality to resist, as happened in one of Liston's earlier cases ; or the new nose may be destroyed by a return of the lupus which proved destructive to the old one. Hæmorrhage also may occur from underneath the flap. In the last case operated on by Liston just before his death, and which was completed by Morton at University College Hospital, hæmorrhage to the extent of more than a pint took place on the ninth day, without any evident cause, from under the flap, and could be arrested only by plugging. Further, the operation is not without its dangers. Dieffenbach lost two patients out of six on

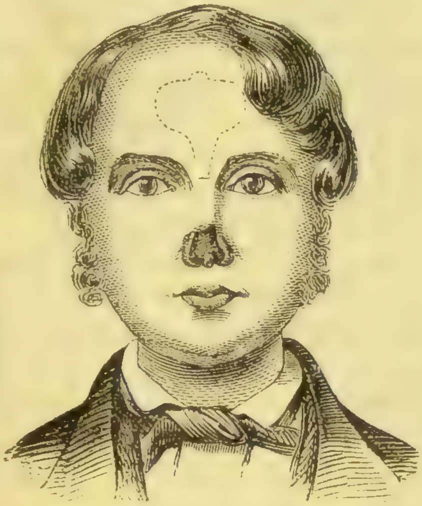


Fig. 707.—Patient before Rhinoplastic Operation.

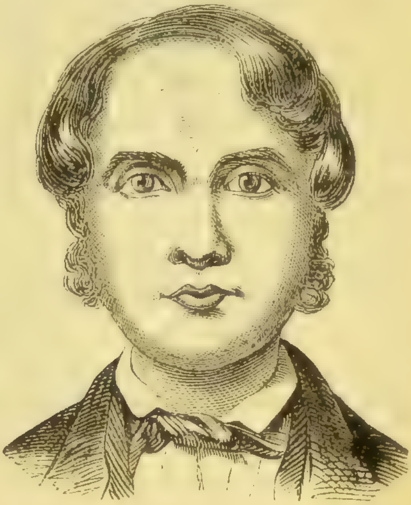


Fig. 708.—Same Patient some months after Operation.

whom he operated; their constitutions having probably been in an unfavourable state.

The operation as just described will usually be attended by very satisfactory results. Of late years some modifications have been introduced into it. Thus Langenbeck recommends that the periosteum should be dissected up from the frontal bone together with the skin-flap, in order that, by the after-development of osseous tissue, a firmer and better organ should be left. It has been feared by some Surgeons that exposure of the frontal bone, by stripping off its periosteum, would probably be followed by necrosis, but experience has shown that this fear is groundless. But it appears to me that there are more serious objections to "Osteo-Rhinoplasty," and that it is an unnecessary complication of the operation to turn down the pericranium in the nasal flap, for two reasons. First, the pericranium is very firmly attached to the bone, and very loosely to the integumental structures, which glide over it. From the bone it is not detached without difficulty and a certain amount of scraping, by which its vitality is likely to be impaired to so great a degree that it would be of no service as a bone-producing organ in the new nose, and would not improbably, when twisted down, slough from insufficient vascular supply. Secondly, even if the periosteal lining of the new nose were to retain its bone-producing power, it seems to me that an osseous layer inside that organ would rather be a disadvantage than otherwise, and would certainly expose it to great risk of fracture and other injury.

The operation practised by Ollier appears to me to be less happy than many of that excellent Surgeon's suggestions. It consists in cutting down the nasal process of the superior maxilla, and then bending it across so as to form a kind of bridge, on which to sustain the tegumento-pericranial flap deflected from the forehead. But by doing this the lateral supports to the bridge of the new nose are removed, and necrosis of the bent or rather broken fragment of bone, which has actually occurred, is not an unlikely accident.

Should the operation fail, or from any reason it be not advisable, the patient may be fitted with a painted vulcanite nose, attached to spectacles, by which the deformity is most efficiently concealed.

FISTULOUS OPENINGS THROUGH THE NASAL BONES leading into the interior of the nose are occasionally met with. Such apertures as these are best closed by paring the edges, and then bringing forward a flap of neighbouring skin by the gliding operation. In some cases of this kind, procedures may be required, in which the Surgeon may display much ingenuity and benefit his patient greatly. The cuts represent a case many years since under my care, before and the day after operation, in which a large aperture into the side of the nose, resulting from necrosis of the left nasal bone consequent on scarlatina (Fig. 709), was successfully closed by a flap of skin taken from the forehead by the twisting process (Fig. 710). The patient, who was a child at the time of the operation, has since grown into a comely woman, presenting scarcely a trace of the operation.

OPERATION FOR DEPRESSED NOSE.—Sometimes the nose is depressed and flattened in consequence of the loss of the cartilages, vomer, and septum, though the external parts remain entire. Dieffenbach has proposed a plan for raising it by slitting it longitudinally into three pieces; dissecting the lateral slips from the osseous attachments; paring the edges to such an extent that they overlap, and stitching them together; then bringing the whole organ forwards by pushing long hare-lip pins across its base, so as to elevate and narrow its attachments, which are brought more into the mesial line. Fergusson has improved this procedure by not slitting the nose down, but dissecting it away from the bones from within the nostril, and then pushing long steel-pointed silver needles across from cheek to cheek, and twisting their ends over perforated pieces of sole-leather, through which they had previously been passed, thus bringing the whole organ bodily forwards. The columna is next fashioned in the way which has already been described; and the nose is completed.

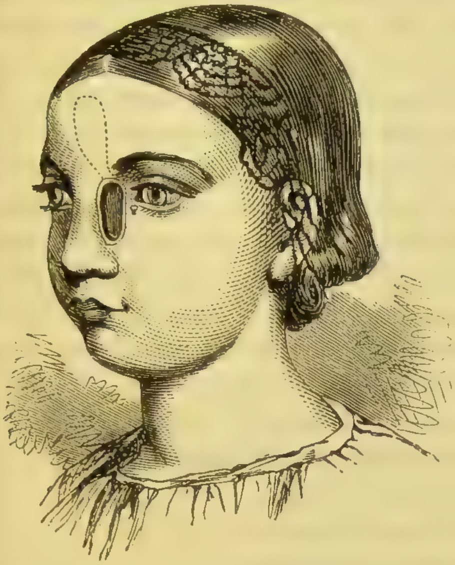


Fig. 709.—Opening into Anterior Nares.

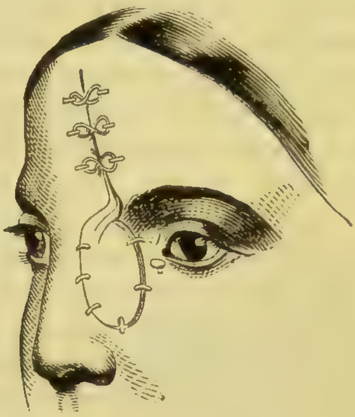


Fig. 710.—Opening into Anterior Nares closed by Operation.

PLASTIC SURGERY OF THE LIPS.

HARE-LIP.—By **hare-lip** is meant a congenital perpendicular fissure or fissures through the upper lip, the result of an arrest of development. Without going into the details of the development of the face, the mode of origin of hare-lip, cleft palate, and congenital transverse fissure of the cheeks, or macrostoma, may be made clear by recalling the main features of the process. The face is developed partly from a central process, the fronto-nasal plate, descending from the front of the cranium between the ocular vesicles. From this are developed the prominent part of the nose, the septum nasi, the columna, the central part of the upper lip, and the inter-maxillary bone with the incisor teeth. The remainder of the face above the line of the lower jaw is developed from a lateral process on each side, the superior maxillary plate, which gradually grows forwards till it coalesces with the vertical process just mentioned. From these processes are developed the cheeks and the whole of the superior maxillary bone, except the part of the palate corresponding to the incisor teeth which, as already stated, is formed from the fronto-nasal plate. The lower jaw, and the soft parts covering it, are formed from similar processes, the inferior maxillary plates advancing from each side and coalescing in the middle line. The superior and inferior maxillary plates coalesce at each side, leaving the open space of the mouth in the middle line. The lines in which these various processes unite are roughly indicated in the diagram on p. 1006, Vol. I. The mode of origin of the various deformities of the face is therefore evident. If one maxillary plate fails to unite with the naso-frontal in front, a cleft will be left through the upper lip on one side of the middle line, forming a single hare-lip. If both plates fail to unite a double hare-lip results, and the intermaxillary bone may be left adherent to the tip of the nose and septum nasi. If at the same time the development of the naso-frontal process is arrested, we get the rare condition of a wide gap in the middle line with absence of the incisor portion of the superior maxilla. If the anterior parts unite but development is arrested posteriorly, cleft palate results, the fissure being single, and in the middle line as far as the posterior part of the premaxillary bone. If the arrest of development is more complete, the fissure may extend to the lip, deviating in front from the middle line as it passes between the main part of the superior maxillary and the premaxillary bone. If both sides fail to unite completely the fissure is single behind and double in front, passing on each side of the intermaxillary bone. In exceedingly rare cases the fissure of the hare-lip has been seen extending upwards on one side of the nose towards the eye. Macrostoma or congenital transverse fissure of the cheeks results from arrested union of the superior and inferior maxillary plates.

Single Hare-lip is by far the most common deformity (Fig. 711). In it the mesial side of the gap is usually rounded ; the outer edge is flattened ; and the frænum at the angle is long and subcutaneous. When **double** (Figs. 712, 713), the fissure is often deeper on one side than on the other, and usually extends into the nostril, and is associated with cleft palate ; though sometimes it stops short of this. In these cases the nose is usually flattened and expanded, and between the fissures there is always a central or median lobule, consisting of the intermaxillary bones in a rudimentary condition ; to this a triangular labial nodule is commonly attached. In many cases this is tilted on its base, so that the alveolar border projects forwards. Sometimes the projection is so considerable that it is attached to the tip of the nose.

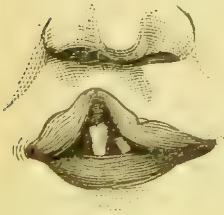


Fig. 711.—Single Hare-lip.

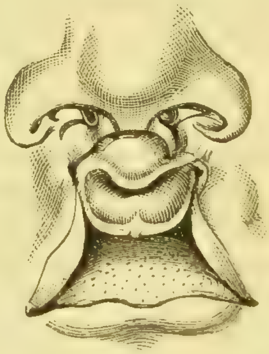


Fig. 712.—Ordinary Double Hare-lip.

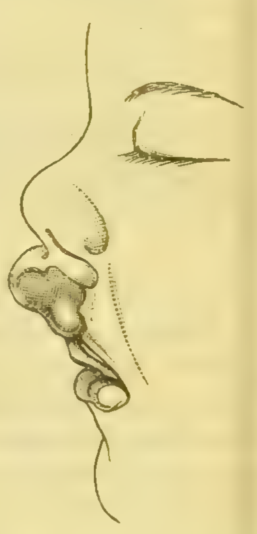


Fig. 713.—Ordinary Double Hare-lip. Side View.

The fissure, when single, may be confined to the lip ; but in the majority of cases it extends to the alveolus of the upper jaw, giving rise to a deep notch between the outer incisor and the canine tooth. When it is double, the four incisors, usually imperfectly and irregularly developed, are included in the central intermaxillary tubercle. Meckel and Nicati have described a rare form of hare-lip, in which the fissure corresponds to the line of junction between the central and lateral incisors. In many cases the fissure extends back into the palate; this more frequently happens when the hare-lip is double, and in these cases every variety of palatal deformity is met with (Fig. 714).

Median fissure is so rare that there are scarcely any authentic cases of it in the records of surgery. Delahaye, however, mentions one instance of mesial fissure of the upper lip with two lateral fissures, and Nicati has described one in the lower lip, the only case of the kind that I have met with on record.

Age for Operation.—The cure of hare-lip can be effected only by a properly conducted operation. In the performance of this, the first point that has to be determined is the age at which it should be done. On this there has been a good deal of difference of opinion. It is now, however, agreed by all Surgeons that the operation should be performed early, before dentition commences. During dentition, I think, it is better not to perform the operation; at all events not during the cutting of the incisor teeth, when there is much local excitement and general irritability of the nervous system. There is no danger in operating in early infancy; on the contrary, very young children, those but a few weeks or months old, bear operations remarkably well. I have repeatedly operated at these tender ages, not only for hare-lip, but for hernia, the removal of tumours and nævi, the division of tendons, &c., and have never seen any bad result follow. Besides this, the performance of the operation is easier at a very early age than when the child has reached its first or second year; when, its intelligence being more developed, it knows what it has to suffer, and screams and struggles more than a very young infant does, whenever it sees the Surgeon, or when he makes an attempt to examine the wound or dressings. After the operation, also, the child will, when young, take the breast without difficulty. At very early ages, union of the wound takes place with great readiness and solidity; and, as no time has been given for the rest of the features to become distorted, there will not be that permanent flattening and deformity of the face which is apt to continue after the hare-lip is cured, if the operation be deferred to a more advanced age. For these various reasons I agree with Fergusson and Butcher, that the operation had best be performed, if possible, at about the sixth week after birth, or from that to the third month, which may, I think, be considered the time of election for this procedure. At this time the vitality of the child is good, and the tissues are not so lacerable as at an earlier age. The operation may safely be performed at a much earlier period in single than in double hare-lip: and the greater the deformity, the more marked the intermaxillary projection, the wiser will it be to defer operation, which becomes increasingly severe with the extent of the deformity. Even in these cases, however, it should not be delayed beyond the third month, as the early removal of the intermaxillary bone, and the pressure of the united lip, tend to narrow the cleft in the palate. Should circumstances require it, however, the operation might be done at a much earlier period than that advised above. Thus, at the urgent solicitation of the parents, I have

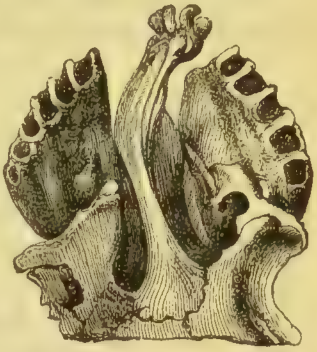


Fig. 714.—Skeleton of Jaw in Double Hare-lip, and Cleft Palate.

performed it within the first twenty-four hours after birth, and several times during the first week. But in these very early days of life the operation is not without danger; the vitality of the child is often feeble, it suffers greatly from the loss of even a very small quantity of blood, and the tissues are so lacerable that there is great danger of the pins or stitches cutting out. I would therefore not advise its performance then.

It is scarcely necessary to observe that, as union by the first intention is aimed at, the operation should not be undertaken unless the health be good; and certainly not if the child, at whatever age, have but recently recovered from measles, scarlet fever, or other infantile disease.

Operation for Hare-lip.—In the treatment of hare-lip, there are three main objects to be kept in view: 1. The procuring of Union by First Intention of the cut edges of the fissure; 2. The Prevention, as far as possible, of deformity during the process of union; and, 3. The Avoidance of all traction on the line of incision that may interfere with these results.

These principles of treatment are carried out by paring the edges of the fissure freely, bringing them together by means of the twisted or interrupted suture, and taking off all tension by means of collodion, strips of plaster and the cheek-compressor. The American "rubber-plaster" will often be found invaluable. But the details of the treatment vary so much, according as the fissure is single or double, or complicated by more or less projection of the intermaxillary portion, that the steps of each operation require to be separately described.

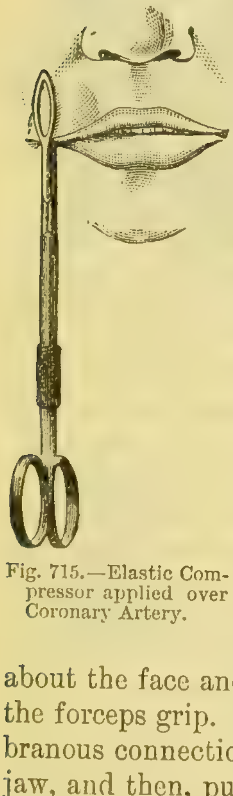


Fig. 715.—Elastic Compressor applied over Coronary Artery.

Single Hare-lip.—The operation for single hare-lip is performed in the following way. The child having been well pinned in a jack-towel that swathes it tightly, the Surgeon, sitting down, places his feet on a stool so as to raise them; and, covering his knees with a piece of mackintosh cloth, holds the child's head firmly between them. Bleeding from the coronary artery of the lip may be prevented, either by an assistant or the Surgeon grasping the lip between his forefinger and thumb, or by compressing the lip with the little contrivance here figured, which consists of ordinary ring-forceps converted into a compressor by having a vulcanized india-rubber ring slipped over the handles. This will be found to be invaluable in many operations about the face and jaws. The lower this ring is drawn down, the tighter will the forceps grip. The Surgeon first freely divides the frænum and all membranous connections between the angle of the cleft and the gum of the upper jaw, and then, putting the lip on the stretch by seizing the extreme edge of the cleft with a pair of artery-forceps or a tenaculum, he pares the edges of the cleft by transfixion with a narrow-bladed bistoury, or fine scalpel, from above downwards, first on one side, then on the other; taking care that the incisions unite neatly and cleanly above the upper angle of the fissure, which must be well cut out; and that they extend sufficiently far outwards to cut away the rounded portion of the prolabium which forms the side of the base of the fissure. The incision on each side must be curved with the concavity towards the fissure (Fig. 721), so that by bringing the two curves into a straight line a slight projection of the prolabium at the point of union shall be produced.

If this be not done a notch will be left when the lip is healed. Care should be taken that enough is cut away; there is more danger usually of taking too little than too much.

Fine hare-lip pins, made of soft iron wire, with hardened points, should then be deeply introduced through the lip from one side of the fissure to the other. The pins should be entered at about a quarter of an inch from the pared edge on one side, and brought out at a corresponding point on the other; care being taken that, though they are passed deeply, the mucous membrane is not transfixed: if it be, it will be doubled into the wound, and thus interfere with union. Two pins are usually required: if the child be some years old, and the fissure very long, three may be used. The lower pin should be introduced first underneath or through the cut coronary artery, in such a way that its pressure may stop the bleeding from this vessel, which is often rather free: in passing this pin, great care should be taken to bring the opposite sides of the fissure well into contact, so as to be on a level below, that no irregularity may be left in the prolabium. The twisted suture is then applied in the usual way (Fig. 716), first round the lower pin, and then round the upper one (separate threads, however, being used for each); and lastly, the two are united by a few cross turns, so as to press down and support the whole length of the fissure (Fig. 717). In applying the twisted suture the Surgeon must be careful, whilst drawing the edges closely into apposition, not to apply the threads too tightly, lest sloughing result; and in crossing them from one pin to the other, great caution must be used not to draw the two pins together horizontally, lest puckering of the line of union take place. The pins are then cut short, the whole is coated with a layer of collodion, and a piece of plaster is put under the ends of the pins to prevent excoriation of the skin. In addition to the pins and twisted suture, I invariably introduce one point of interrupted suture through the mucous membrane of the lower part of the fissure, just inside the mouth; and I look upon this as of great importance in preventing the notching, which is otherwise very apt to occur, in consequence of that portion of the incision between the lower pin and the edge of the lip being kept open by the child in sucking, or protruding its tongue against it. If the fissure be wide, and the child restless, so that there is danger of the parts being dragged upon during its screaming or crying, it is a very good plan to apply the spring cheek-compressor, invented by Hainsby, here represented slack (Fig. 718). It must fit the child accurately, and commonly requires to be made specially for the case. The same effect may be obtained by drawing the cheeks together by a piece of muslin cut so as to form a large rounded piece in each cheek connected by a narrow strip over the lip. This must be applied while the cheeks are pressed together with the

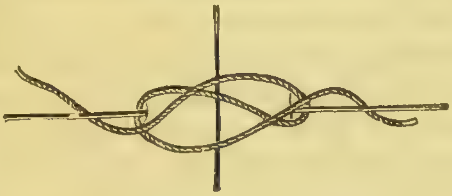


Fig. 716.—Application of Twisted Suture.

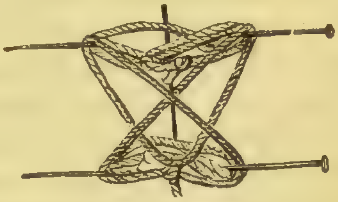


Fig. 717.—Application of Pins and Sutures in Hare-lip.

fingers and sealed down with flexible collodion. American rubber-plaster may be applied in the same way, but is not so efficient.

After the operation the lips often come in close contact, and care must be taken to clear the nostrils from clots of blood, otherwise the child may be suffocated, especially if chloroform has been administered and the effects have not fully passed off.

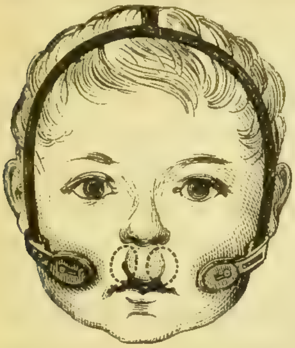
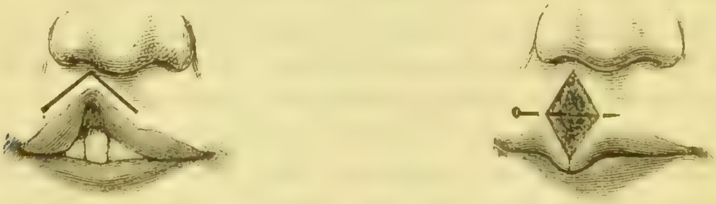


Fig. 718.—Hare-lip: Spring Cheek-compressor.

At the end of from 72 to 96 hours, according to the age of the child, the pin should be withdrawn, or it may be removed by a gentle rotatory movement, in such a way that the cut end does not tear or lacerate the aperture in the lip. The threads, matted together with exudation and a little blood, form a good crust, which may be left on for two or three days longer, and then allowed to separate of itself; the less any crusts that form over the line of incision are interfered with, the better will the result usually be. The lip must be supported by the muslin and collodion or a strip of American rubber, continued for about a fortnight after the operation, so as to prevent stretching of the cicatrix and notching of its lower part. The point of interrupted suture may be left in for about four days. It sometimes, though rarely, happens in single hare-lip that the intermaxillary portion is so large and projecting, that there is difficulty in bringing the lateral segments together over it. Should this be the case, the better plan is to notch it at its alveolar border on the side that is not fissured, and then to break it back so as to remove all projection.

When the fissure does not extend through the lip the operation recommended by Nélaton will be found to give most excellent results. The mode of performing it is fully explained by the accompanying figures (Figs. 719 and 720.)

Double Hare-lip.—The operation for double hare-lip is performed on the same principle as that for the single form of the disease, the difference in the operations consisting chiefly in dealing with the median portion of the lip and the intermaxillary bone (Fig. 721). The management of the intermaxillary process must vary according to its size and degree of projection. If it be small and rudimentary, or fixed to the tip of the nose, as in Fig. 722, it should be cut off with bone-nippers, as it would prevent the lateral segments from coming into proper apposition. Most commonly, when this is done, there is free and even dangerous bleeding from a dental artery deep in the bone, which may require to be touched with a cautery before the hæmorrhage from it will cease. If the intermaxillary portion be large and projecting, it has been



Figs. 719 and 720.—Nélaton's Operation for partial Hare-lip.

the incisor teeth contained in the intermaxillary portion will, if they develop at all, project backwards into the roof of the mouth, as the bone is not pushed into its normal situation, but rather rotated on its transverse axis, the slender neck attaching it to the vomer being bent upon itself. He was of opinion therefore that in all cases it is better to remove the bone than to attempt to force or bend it into a new position. If it be large and not projecting, the soft parts should be well pared on each side, and transfixed by the hare-lip pins, and thus be interposed between and united to the pared lateral surfaces; indeed, it is always advisable not to remove this, unless it be awkwardly situated, as in Fig. 722. When it is left, though the union may not appear quite so perfect and uniform as it would if the lateral halves had been directly united, yet eventually the case will turn out better; the central portion becoming developed, and forming the natural mesial projection of the lip, which is lost when the lateral halves are directly united. In some of these cases great nicety is required in planning the incisions, and in the introduction of the sutures. The central portion is most advantageously pared in a somewhat convex manner, so that the freshly cut edges of the lateral halves are more accurately fitted upon it. Should, as often happens in single as well as in double hare-lip, one of the lateral segments be tied down to the gum by a doubling of mucous membrane, this must be freely divided, and the portion of lip, with perhaps the corresponding ala of the nose, freely dissected up from the osseous structures, so as to admit of its being moved forwards without too much traction being put upon it.

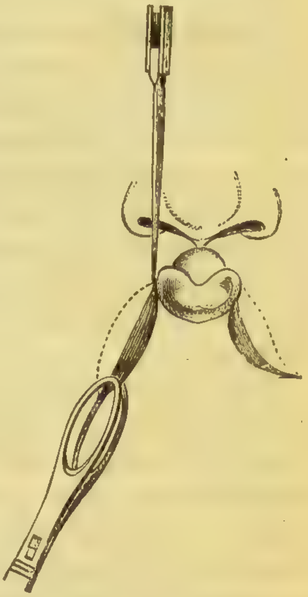


Fig. 721. — Operation for Double Hare-lip. Right side of Lip drawn down by Spring-hook Forceps: long narrow Knife entered at angle: dotted line shows direction of the Incisions.

In those cases in which the intermaxillary portion is projecting, and attached to and fused with the columna of the nose, as in Figs. 722 and 723, I have performed the following operation with great success.

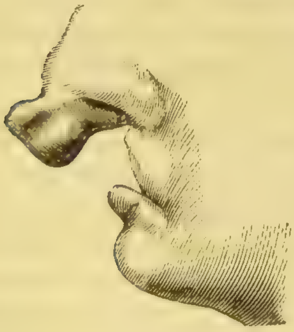


Fig. 722.—Double Hare-lip: Intermaxillary Portion fixed to Nose.

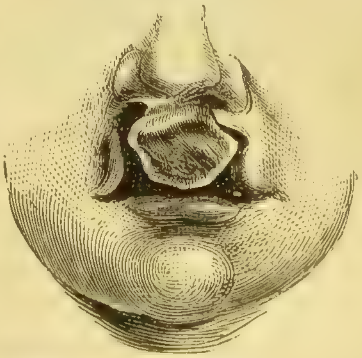


Fig. 723.—Double Hare-lip: Projecting Intermaxillary portion.

3. The edges of the lateral fissures are then pared in the usual way. 4. The free lower margins of the pared edges are brought together by one hare-lip pin and twisted suture. 5. The leaf-shaped flap is then laid down in the triangular hollow left above the pin, and retained there by one or two points of silver suture on each side, the gap being thus completely filled up by it.

Treatment by Simple Suture.—During several years I have been in the habit of treating hare-lip of all kinds, double as well as single, with the simple interrupted suture alone, without using any pins. I have in this way treated many cases in children, whose ages have varied from a few days to four years, with most satisfactory results, and with less marking of the lip than I have ever seen attend union by means of the twisted suture. I therefore prefer the simple to the twisted suture, provided the case be not too complicated, nor associated with very wide fissure in the palate, or with great projection of the intermaxillary bones. In these circumstances, the pins should be preferred.

When the fissure is single, the edges, having been pared in the usual way, should be brought together by two points of suture; the first passed deeply near the free edge, and in such a way as to compress the cut coronary artery; the other nearer the nasal angle. These sutures should be of thick silver-wire or silkworm gut that will not cut out too readily. A few points of interrupted horse-hair suture may be inserted superficially to ensure the perfect apposition of the edges, and another should then be inserted through the mucous membrane inside the lip. The lip may then be supported by the muslin and collodion as before described. On the fourth day the deep sutures should be taken out, but the finer stitches may be left in for a day or two longer. The lip must then be supported for a few days with muslin and collodion or a strip of plaster.

In the case of double hare-lip the same plan is to be adopted, first on one side, then on the other; but here, as the gaps are wider, and the tension, more particularly when the intermaxillary prominence is very projecting, is apt to be considerable, it is necessary to support the cheeks, and thus to prevent undue traction on the stitches, by means of the cheek-compressor (Fig. 718) or properly applied collodion or plaster. In this way all risk of the stitches cutting out before union is completed is avoided; an excellent and solid union will speedily be obtained even in cases of double hare-lip, with some inter-maxillary projection and fissured palate.

The operation occasionally fails. The probability of the occurrence of such an untoward event is, however, greatly diminished by the use of the cheek-compressor or collodion. It may, however, happen either in consequence of the child's health being in so unsatisfactory a state, as to prevent union by the first intention; or in consequence of the pins or sutures having been taken out too early, before secure cohesion has been effected. In such circumstances as these, an attempt might be made to unite the granulating edges by the re-introduction of the pins or sutures, and by firmly fixing the lip by means of the cheek-compressor or plaster applied as above described. Such attempts, however, rarely succeed; should they not do so, it will usually be found most prudent to wait at least a month before taking any further steps, and then to pare the edges afresh and repeat the original operation.

malar bone, are occasionally met with. Their mode of origin has been already referred to (p. 641). In these malformations, which are of extremely rare occurrence, the ear on the affected side is imperfectly developed. As has been observed by Fergusson, the tragus is detached from the auricle, and is fixed to the cheek, where it forms a small lobulated appendage. The external ear generally is malformed, the helix being twisted and curled inwards. These malformations require to be treated on exactly the same principles, and with the same attention to details, as hare-lip; union between the pared edges being effected by means of hare-lip pins and the twisted suture.

Cheiloplasty.—Simple plastic operations are commonly practised on the lower lip for the removal of epithelioma, by cutting out a V-shaped piece of the lip, including the whole diseased structure, and then bringing together the opposite sides of the incision by sutures or hare-lip pins. These operations have already been described and figured at p. 585, Vol. II. We shall consider here those cases in which it becomes necessary to repair more or less extensive loss of substance in the labial structures. The plan originally introduced by Chopart consisted, when it was the lower lip that was affected, in carrying an incision on each side of the diseased portion of the lip vertically downwards below the jaw, for a greater or less distance according to the amount to be removed, if necessary, even as far as the hyoid bone. The diseased part of the lip was then removed by a transverse incision below it. The square flap marked out by the two vertical incisions was then detached from above downwards. It was then brought up, and fixed to the pared edges of the remaining portion of the lip by points of suture; the head being kept properly inclined, in order to prevent undue tension. After sufficient union had taken place to preserve the vitality of the flap, its lower attachments were divided. This operation was not very satisfactory in its results, as the new flap was apt to become œdematous and inverted at the edge, or the flow of saliva interfered with proper union, and it is not now practised. In those cases in which the greater portion of the lower lip has been excised for cancerous disease affecting its upper margin, a better procedure for the restoration of the deformity consists in a modification of the plan recommended by Serres; and from this I have derived excellent results, as in the case which is here represented (Fig. 724). The object of the operation is to raise the lower lip to a level with the incisor teeth. An incision, about three-quarters of an inch in length, is made directly outwards from the angle of the mouth, on each side, into the cheek; from the extremity of this

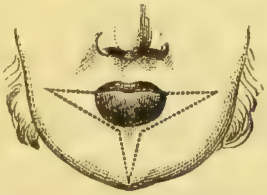


Fig. 724.—Lines of Incision in Cheiloplasty.

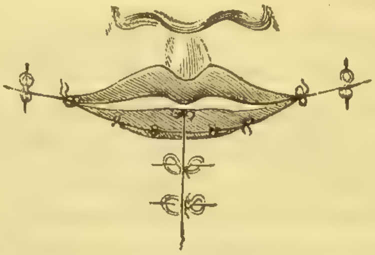


Fig. 725.—Incisions and Sutures in Cheiloplasty.

taken out of its centre. By means of a hare-lip pin on each side, and a point of suture, the incisions in the angle of the mouth are brought accurately together; and in the same way the vertical one, in the centre, is united (Fig. 725). In this way the whole of the lower lip is raised, and brought more forwards. If care have been taken in removing the cancer from the edge of the lip, to leave the mucous membrane rather long (which may always be done, when the skin is affected to a greater extent than it), a good prolabium may be formed, and the restoration effected with but little deformity.

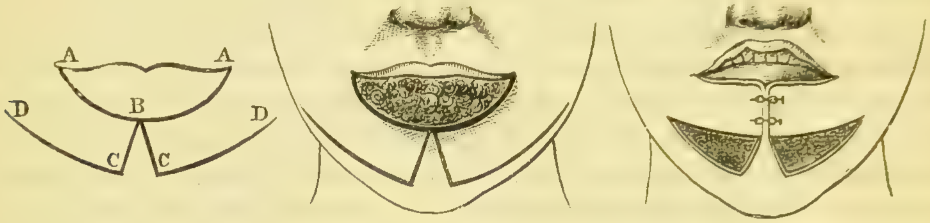


Fig. 726. Fig. 727. Fig. 728.

Buchanan's Operation for the Restoration of the Lower Lip.

Buchanan, of Glasgow, as far back as 1841, published an account of a method for restoring the lower lip, which leaves very satisfactory results. The accompanying figures illustrate the kind of case in which Buchanan's operation is applicable, the lines of incision required, and the appearance presented by the chin and lip after the disease has been removed, and the flaps brought into proper apposition.

The steps of the operation are simple. The diseased part of the lower lip is first removed by an elliptical incision (Fig. 726, A B A). An incision, B C, is then carried downwards and outwards on each side of the chin; and another incision, C D, upwards and outwards parallel to, and corresponding in length to, A B. The flaps formed by these incisions are represented in Fig. 727. They are detached from their subjacent connections; and the whole is raised upwards, so that the curved incision, A B, comes into a horizontal line, and is made to constitute the margin of the new lip; the secondary incisions, B C,

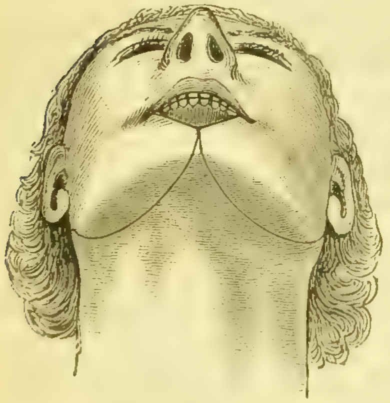


Fig. 729.—Syme's method of restoring the Lower Lip. Lines of Incision.

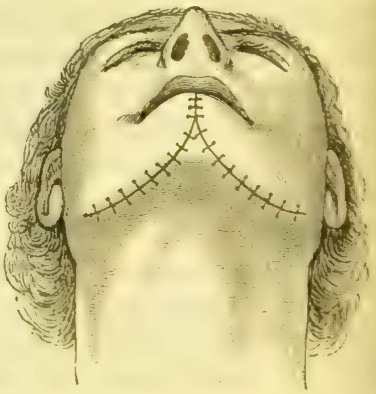


Fig. 730.—Syme's method of restoring the Lower Lip. Operation completed.

are raised are left to heal by granulation and this forms an objection to the operation, as the contraction of the sores tends to draw the new lip downwards. Syme therefore recommended a somewhat different mode of operating. Instead of the incisions C D being made, those marked B C are carried onwards for some distance in a direction curving downwards and outwards, so that they terminate below the angles of the jaw. The flaps so formed are raised and united in the middle line, as in Buchanan's operation, the ∧-shaped portion of skin above the chin serving to maintain them in position and prevent their sliding downwards. The long curved incisions enable this to be done by merely stretching the convex edges of the flaps, without sufficiently displacing them to prevent their readily meeting the concave edges of intervening skin, and being united to them by sutures. No surface is therefore left to granulate, and the whole wound heals by the first intention. In performing this operation it is essential to success that the incisions should be sufficiently free, so that the flaps may be brought into position without tension. If the chin be removed as well as the lower lip, it becomes very difficult to restore the loss, as there is no fixed point below to support the new lip, which consequently tends to sink downwards.

PLASTIC SURGERY OF THE PALATE.

Various degrees of congenital deformity may occur in the palate and uvula: thus the uvula alone may be bifid; or the cleft may extend through the greater part or the whole of the soft palate; or the hard palate may be divided as well (Fig. 731); and, lastly, the separation may extend forwards to the integuments of the face, producing single or double hare-lip (Fig. 714). The soft palate and uvula are not unfrequently cleft without the hard palate being divided; and, in some very rare cases, the lip and the hard palate are fissured without the soft being cleft. The mode of origin of these deformities has already been described (p. 641).

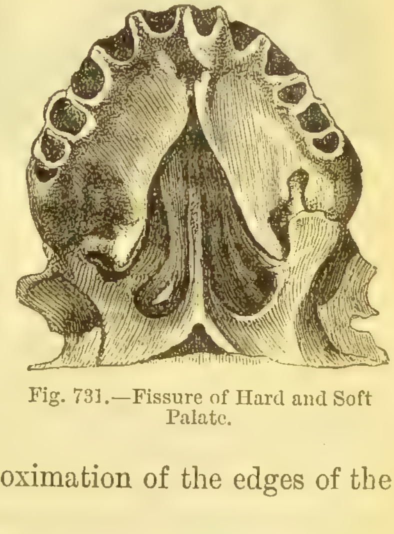


Fig. 731.—Fissure of Hard and Soft Palate.

These malformations necessarily give rise to great inconvenience, by interfering with deglutition, and rendering speech nasal and imperfect. During the swallowing of fluids, there is a tendency to regurgitation through the nose, though this is occasionally prevented by the approximation of the edges of the fissure in the soft palate.

An infant born with a complete cleft of the hard and soft palate is necessarily unable to suck, and unless carefully fed by hand will soon perish. It must be fed solely on milk, the mother's milk being the best, which may be drawn periodically and administered to the child. The feeding may be done by a properly constructed bottle, from which the milk will flow slowly without the necessity of sucking on the part of the child; this must be fitted with an india-rubber tube, which must be pushed well to the back of the pharynx as patient had attained the age to understand the necessity of remaining quiet during the proceeding, and was able to control his movements, as success depended in a great measure upon his remaining perfectly steady during the necessary manipulations, which are of a painful and protracted character; and upon his assisting the Surgeon by opening his mouth, and not struggling during the introduction of instruments. Chloroform was never administered, from the fear that suffocation might be caused by the blood from the operation, which is always abundant, entering the air-passages. In 1869, however, Thomas Smith, of St. Bartholomew's Hospital, demonstrated that with proper care anæsthetics may be safely administered, and at the same time he invented a most ingenious gag, by means of which the patient's mouth can be kept widely open without the Surgeon being interfered with either by the hands of assistants or the instrument itself. By the help of this gag, and the administration of chloroform, the operation can now be performed at any age; but as the bleeding is always very free, it is advisable not to attempt it in too young children. If the cleft implicates the soft palate only, it may safely be closed at the age of three if the health is good and other conditions favourable, and the advantage of having it done before the child has learned to speak is very great. If the hard palate is involved, it is better to wait till the sixth or seventh year.

Staphylorrhaphy.—The operation for the cure of a cleft in the soft palate may be said to have been first established as a definite surgical proceeding by Roux, but it has subsequently undergone many changes and improvements in the hands of Warren, Sédillot, Dieffenbach, Liston, Sir W. Fergusson, G. D. Pollock, T. Smith and others.

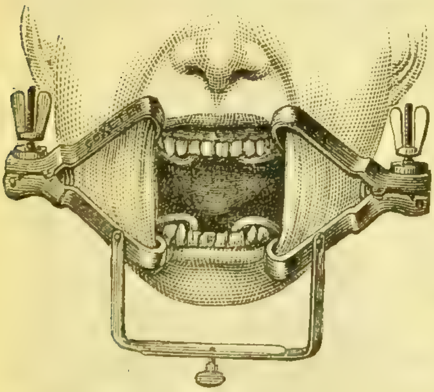


Fig. 732.—Wood's modification of Smith's Gag.

Operation.—The patient is placed in a recumbent position, the Surgeon standing on his right side. The gag is then inserted, or if the patient be nervous this may be delayed till the anæsthetic has been administered. Chloroform will be found the most convenient anæsthetic, as it gives rise to less secretion of mucus. It may be given by means of Junker's apparatus through an india-rubber tube passed into the pharynx through one nostril. The gag represented in the accompanying drawing (Fig. 732) is a modification of Smith's by Wood. It can be adjusted to fit any patient by more or less widely separating the two halves. The first step in the operation consists in *paring the edges of the fissure* by means of a narrow sharp pointed knife like a tenotome set in a long handle. This is best done by seizing the lower end of the uvula on one side in a pair of toothed forceps and putting the corresponding half of the palate on the stretch. The cut may be made from above downwards or from below upwards, first on one side and then on the other, but whatever plan is adopted great care must be taken not to leave a portion of mucous membrane behind in the angle of union. A sponge pressed into the gap will quickly arrest the bleeding, or a piece of ice fixed in a

Surgeon proceeds to the next step, that of *introducing the sutures.* The best material for these is in most cases fine silver wire or silkworm gut. Cat-gut is absorbed too readily and is apt to yield before union is complete. Silk, which was formerly used, cannot be retained beyond a few days, as it excites too much irritation when soaked in decomposing fluids. Horse-hair will be found useful in uniting the uvula, but is not strong enough for the other parts of the palate. Wire stitches are usually introduced by Smith's tubular needle specially constructed for the purpose, from which the wire is protruded by a small wheel at the lower end. In the absence of this apparatus they may be very readily passed as follows : a common nævus needle is threaded with a loop of fine silk ; this is passed through the right side of the cleft and drawn out at the mouth. A similar loop is then passed on the left side. The right loop is then passed through the left, which is withdrawn, carrying the first loop with it through the left side of the palate. There is thus a double ligature passed across the cleft, having two free ends on the right side and a loop on the left. A fine hook is then made with a pair of dissecting forceps on a piece of wire ; this is hooked into the loop, which is then withdrawn, carrying the wire with it across the cleft. This proceeding, though it seems rather complicated in a written description, can be carried out with great ease and rapidity ; and the needle being passed on both sides from before backwards, the sutures can be inserted more accurately and evenly than when on one side it is passed from behind. The stitches should be about one-sixth of an inch apart, and must all be introduced before any are tightened. If there is likely to be any tension, one or perhaps two thicker silver sutures may be inserted to take the chief strain. The next step in the operation will depend upon the amount of tension that is present when the edges are drawn together by pulling gently on the middle stitch. If the edges come readily together without any strain, all the stitches may be at once tightened by tying them if the wire be sufficiently pliant, or by twisting them with a pair of torsion forceps, or a special apparatus constructed for this purpose. In the majority of cases, however, it will be necessary to make a lateral incision on each side to relieve tension. This is done by puncturing the palate with a

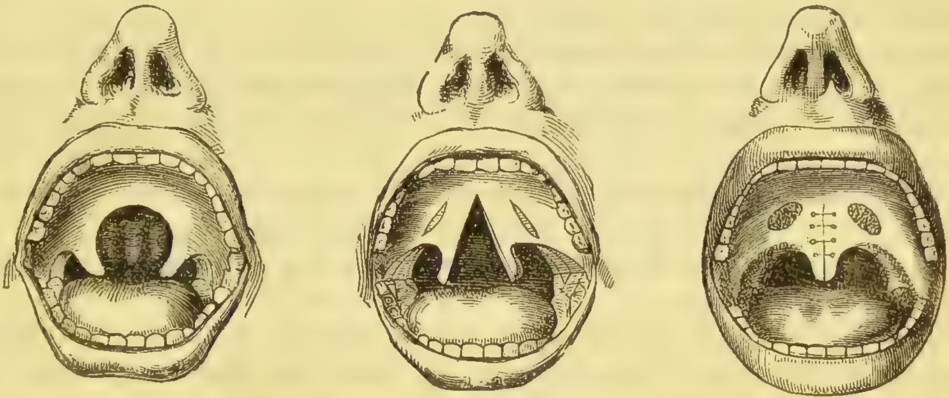


Fig. 733. Fig. 734. Fig. 735.

Sédillot's Operation for Staphylorrhaphy.

fibres of the levator palati be divided without greatly increasing the puncture in the anterior surface of the palate. It will be found better, however, as a rule, to follow the plan employed by Sédillot (Figs. 733, 734, 735), and after puncturing the palate with a sharp knife to introduce a narrow blunt pointed knife, and to make a slit of sufficient length completely to remove all tension. An incision of equal length must be made in the opposite half of the palate, and the sutures may then be tightened. The lateral incisions always heal without difficulty, even if they gape widely at the time of the operation. If necessary, tension may be further relieved by snipping the anterior and posterior pillars of the fauces, after making them prominent by pulling on the palate. Sir W. Fergusson recommended the division of the muscles from behind without perforating the palate. This is more difficult of performance, and gives less perfect relief of tension ; in fact it was intended rather to give rest by paralysing the muscles than to relieve the strain on the stitches. He considered the levator palati and the palato-pharyngeus to be the two muscles exerting the most disturbing influence on the wound. The former he divided by passing a lancet-ended knife bent nearly at a right angle with its handle, through the fissure behind the velum, midway between its attachment to the hard palate and the free margin, and about halfway between the velum and the end of the Eustachian tube, and cutting deeply in that situation. The posterior pillar of the fauces was divided simply by making it tense by pulling on the soft palate and then snipping it through with scissors. Fergusson divided those muscles as a preliminary step before paring the edges in all cases.

The chances of success depend very much upon the absence of tension. The stitches should simply hold the parts in contact, not drag them together. It is safer, therefore, to adopt Sédillot's plan as being more efficient as well as easier of performance.

After the operation the patient must be put to bed, and every care taken to avoid any movement of the palate. He should be restricted to fluid but nourishing food for a few days, and should be directed to swallow this with as little effort as possible, and indeed should not be allowed anything solid until complete union has taken place. Speaking must be strictly forbidden until union is complete. *The stitches should not be taken out for at least three weeks or a month.* If there is any tension they will probably cut their way out ; if there is none, being of silver wire, they excite no irritation, and, moreover, they serve the important purpose of supporting the scar in the middle line while the lateral wounds are healing. It is a good rule not to even look into the patient's mouth for the first week after the operation. Should there be any aperture left in the palate, where union has not taken place, this may be closed by touching it with a point of nitrate of silver, or the thermo-cautery.

The voice in these cases does not usually recover its natural tone, although in some cases it may. The nasal or "Punch-like" voice that is often left after operations, appears to arise from two causes. The first is the mere habit of faulty articulation, and this can be corrected by careful instruction in elocution. The second, which is much more difficult to deal with, arises from a mechanical condition, and is dependent on the contraction upwards of

Uranoplasty.—Fissures of the Hard Palate are usually closed by means of "obturators" made of gold, vulcanite, or ivory. To Warren, of Boston, is undoubtedly due the merit of having been the first to close these fissures by a surgical operation. The operation was first brought before the Profession in this country by Avery and subsequently by Pollock, who have invented some very ingenious instruments for its proper performance. Warren operated by dissecting the soft tissues from the palatal arch between the margin of the cleft and the edge of the gum, and then uniting them in the middle line by means of stitches in the same way as in fissured soft palate.

If the arch of the palate be very high, there may be sufficient tissue to meet in the middle line when separated from the bone and allowed to hang down, but it is better not to trust to this, but to make an incision on each side. The operation is performed in the following way in a case of complete cleft of the hard palate. An incision is made from near the canine tooth parallel to the alveolar margin and about a third of an inch, or less, internal to it, reaching backwards to a little beyond the last molar. When the cleft is narrow or the arch high, a smaller incision than this will suffice, which may be lengthened afterwards if necessary to relieve tension. A second incision is then made along the edge of the cleft at the junction of the nasal and palatal mucous membranes. This incision must be carried backwards into the soft palate, from which a strip of mucous membrane must be removed, as in the operation for closure of clefts implicating that part only. The soft structures covering the hard palate are then raised from the bones with a curved periosteal elevator, shaped somewhat like an aneurism needle. In fact, if the proper instrument be not at hand, a strong aneurism needle will answer the purpose admirably. The periosteum should be raised with the flap as completely as possible. Langenbeck pointed out, that if this be done, not only are the flaps thicker and stronger, but they may eventually throw out bone, and thus more efficiently close the gap in the hard palate. In raising the flaps, care must be taken to avoid those points anteriorly and if possible posteriorly where the blood-vessels and nerves enter. Another point of equal importance, as pointed out by Thomas Smith, is to separate the attachment of the soft palate to the hard with a sharp instrument, either a pair of scissors or a knife bent at a convenient angle. If an attempt be made to tear this through with the elevator, the parts will be so bruised that union by first intention will not take place even if sloughing be avoided. When these structures have been well loosened on each side, the covering of the palate will be found to hang down as a curtain from the vault of the mouth—the two parts coming into apposition along the mesial line, or possibly over-lapping. The edges are then brought into apposition by means of wire sutures introduced as before described and without any dragging. On this point great care is necessary. In cases in which the flaps do not meet readily, one or more deep sutures of thicker wire may be inserted further from the edges, so as to relieve the strain on the finer stitches; or, if necessary, the lateral incisions may be continued back some way into the soft palate. Care must be taken also that the edges of the flap are not inverted so that the mucous surfaces are in contact. To prevent this it may be necessary to draw them down with a sharp hook for several days, and allowed an abundant, but fluid or pulpy diet. Union, if it take place, will usually be found to be perfect at the end of a week. The wire sutures need not be removed for a month or six weeks. In fact, it is much safer to retain them until healing is complete, not only in the middle line but in the two lateral wounds as well, otherwise the contraction of the granulations as healing takes place may tear open the young cicatrix in the middle line.

When the cleft is wide, and, as usually happens, the septum nasi is adherent to one edge, T. Smith recommends that the incision instead of being made at the junction of the nasal and palatal mucous membranes should be carried some distance up the septum, from which the mucous membrane can be detached with a sharply curved raspatory.

Secondary hæmorrhage of a somewhat serious character has been known to occur after this operation. In one case of this kind, Howard Marsh successfully arrested the bleeding by plugging the posterior palatine canal with a piece of wood.

Sir William Fergusson suggested a modification of the operation, in which an incision was made on each side of the fissure, and the bone divided longitudinally with a chisel, the two edges being then forced into contact. Although in his own hands some satisfactory results were obtained by this method, further experience has led to the abandonment of this operation as being in no way superior to that already described, and being somewhat liable to be followed by necrosis of the divided bone.

It was formerly advised by some Surgeons, not to undertake the closure of the hard and soft palate at the same time, but it is now generally recognized that nothing is gained by dividing the operation into two parts.

Success will very much depend on the proper selection of cases. Fergusson considered that about one-half of the fissures of the hard palate admit of operation. If the cleft be very wide, a well-constructed obturator will probably give more relief to the patient than any operative procedure. In fact, at the present time Dental Surgeons have brought the obturators for cleft palate to such perfection that it is a question whether any adult who is in a position to pay the necessarily heavy cost of such an instrument, should be advised to submit to operative interference.

Perforation of the Hard Palate.—Perforations of the hard palate, consequent on necrosis of the bones, the result of syphilis or injury, are not amenable to surgical treatment. In such cases, a well fitting obturator will most effectually remedy the inconvenience.

CHAPTER LVIII.

DISEASES OF THE MOUTH AND THROAT.

DISEASES OF THE TONGUE.

Tongue-Tie.—Infants and even adults are said to be *tongue-tied*, when the frænum linguæ is shorter than usual, causing the end of the tongue to be slightly bifid, depressed, and fixed, so that it cannot be protruded beyond the incisors. If this malformation be considerable, suckling and distinct articulation may be interfered with ; and then division of the fold becomes necessary, which may readily be done by snipping it across with a pair of round-ended scissors ; the risk of wounding the ranine arteries being avoided by keeping the point of the scissors downwards towards the floor of the mouth.

Hypertrophy and Prolapsus of the Tongue or Macro-glossia is occasionally met with, either as a congenital or acquired condition. Of 113 cases collected by A. E. Barker, in only 39 was it apparently acquired, and in most of these it appeared at a very early age. In this condition, the tongue lolls out of the mouth with constant dribbling of saliva, is greatly swollen, of a purplish colour, but somewhat dry. If the swelling have existed for a long time, it may give rise to deformity of the teeth, and of the alveolus of the lower jaw, which is pushed forwards. The protruded tongue is liable to attacks of sub-acute inflammation, which lead to its still further increasing in size. The *Pathology* of this condition was first clearly pointed out by Virchow. There is a great over-growth of the interstitial connective tissue of the tongue, and in this tissue are found dilated lymphatic vessels of considerable size, and spaces filled with lymphoid cells. It presents, therefore, a close analogy to elephantiasis. In many cases the dilated lymphatics form so important an element in the new tissue, that the disease has been termed by some writers "lymphangioma of the tongue." In the *Treatment* of this disease pressure has been attempted by strapping the protruding part, but without benefit. Excision of a portion of the tongue by the knife, scissors or écraseur is the only efficient remedy. In some cases the removal of a V-shaped piece will give the best result. This operation was successfully

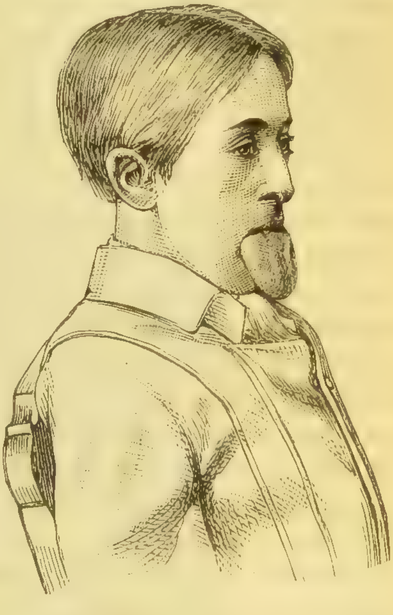


Fig. 736.—Hypertrophy and Prolapsus of Tongue in a boy.

Inflammation of the Tongue or Glossitis is not a common affection. The most frequent form is that which arises from immoderate and injudicious administration of mercury. In this the tongue becomes greatly swollen ; it may hang from the mouth, with profuse discharge of saliva and inability on the part of the patient to swallow or speak, and perhaps a threatening of suffocation. The sides are marked by deep impressions of the teeth, in which after a time foul ulcers may form. Acute glossitis with great swelling of the organ occasionally occurs after fevers, and more rarely without any apparent exciting cause. In this form there is acute pain with considerable febrile disturbance. The tongue swells rapidly, so that in a few hours it may reach such a size as to threaten suffocation. The dyspnœa may be due to the obstruction caused by the swollen tongue, or to extension of the œdema to the arytæno-epiglottidean folds. The inflammation may end in resolution or lead rapidly to the formation of pus. The *Treatment* of glossitis varies with the cause and the degree of swelling. If of mercurial origin, the removal of the cause, and the administration of saline purgatives and a chlorate of potash gargle, will usually arrest the progress of the inflammation. If the swelling be very great, more especially in the idiopathic form of the disease, the only efficient treatment consists in making a free incision along the dorsum of the tongue on each side of the raphe, which gives free and immediate relief by the escape of blood and infiltrated fluids. I have seen a patient, who was nearly suffocated by the size of his tongue, relieved at once by such incisions, and nearly well in the course of a few hours.

Chronic Abscess of the Tongue, though rare, occasionally occurs. I have seen several instances of it. The abscess forms a small deeply seated elastic but firm tumour, which sometimes feels slightly movable. There is no discoloration or other change in the mucous membrane or epithelium of the tongue. The walls of these abscesses are very thick and dense ; hence they may be easily mistaken for solid tumours. The abscess is always very chronic, hence the liability to error in diagnosis is increased. It is commonly seated at the edge and towards the anterior part, but it may occupy the middle of the tongue. A boy was once brought to me with an elastic tumour of slow growth, and of about the size of a small plum, situated deeply in the centre of the tongue ; on puncturing it, about half an ounce of healthy pus was let out, after which the cyst speedily closed. The *Treatment* consists in making a longitudinal incision into the abscess. In all cases of doubt in diagnosis, this should be done before any other operation is undertaken.

Chronic Superficial Glossitis — Psoriasis or Ichthyosis of the Tongue — Leucoplakia.—Under these names a diseased condition of the tongue has been described which is far from uncommon in this country and in France, but is said to be much less frequent in Germany. The disease consists essentially of a chronic inflammation of the mucous membrane of the tongue. In the earliest stages there is hyperæmia of the papillæ, with some swelling. If seen at this period the mucous membrane presents red patches, usually limited to the dorsum of the tongue, but occasionally appearing simultaneously on the cheeks, and passing through the same stages there as on the tongue. It can be recognized clearly only after the mucous membrane has been papillæ and epithelium. As the disease advances, an excessive growth of epithelium takes place over the swollen papillæ. The superficial layers of cells become horny and opaque, the neighbouring spots coalesce, and thus white patches of considerable size form on the mucous membrane, from which appearance the name of *leucoplakia* was suggested by Schwimmer. As the disease advances, the papillæ and the superficial parts of the corium present the ordinary signs of chronic inflammation, the vessels are dilated and the surrounding tissues infiltrated with small round cells (Fig. 737). The next stage in the process is characterized by atrophy of the papillæ. The opaque patches then become perfectly smooth. In this stage the surface of the tongue is somewhat indurated, having upon its surface smooth patches of a dead-white colour irregular in shape, and varying in size from that of a split pea to an inch in diameter. This condition closely resembles the appearance of psoriasis of the

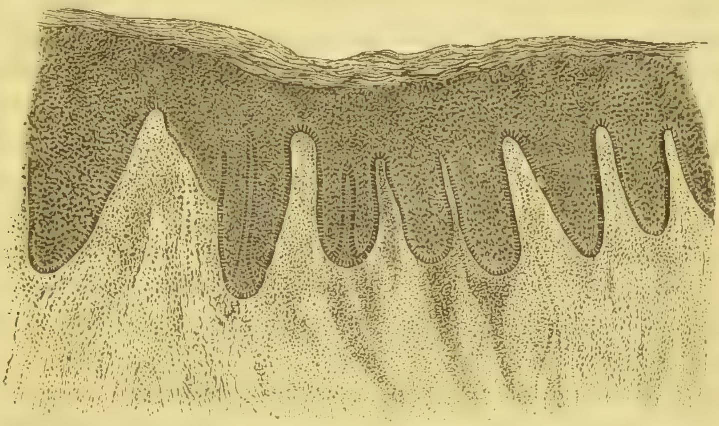


Fig. 737.—Chronic Superficial Glossitis, showing the alteration in the size and shape of the papillæ, the flattening of the surface with heaped-up epithelium, and the small-cell infiltration of the sub-epithelial tissue.

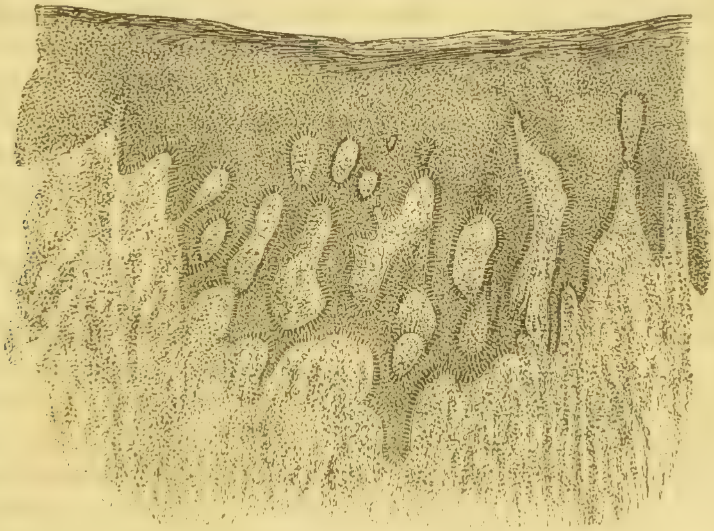


Fig. 738.—A portion of the same tongue, nearer the tip, showing the development of squamous carcinoma. The epithelium is invading the deeper tissues in processes or columns.

an exaggeration of the process already described. At some point, possibly as the result of injury, the small round cells become increased in number by migration from the vessels, the epithelium becomes loosened and is rubbed off by the movements of the tongue, and a raw surface is thus left, from which ulceration may gradually extend. A more serious result is the supervention of epithelioma, which is a common termination of the disease. Microscopic examination of a tongue in which this is taking place may show all the stages of the disease in one section : at the margin of the patch will be enlarged papillæ covered with a thick layer of epithelium ; nearer the centre the papillæ have disappeared, the corium being covered by a thick layer of epithelium, the greater part of which is composed of flattened horny scales : near the centre the cells of the rete mucosum are seen to be growing actively and forming columns which force their way into the spaces of the submucous tissue, and further on, amongst the muscular fibres. These columns are surrounded by the zone of small-cell infiltration always seen at the edge of a growing cancer (Fig. 738).

Various modifications of the process above described may be met with ; thus, in some cases the growth of epithelium is less abundant, so that instead of the formation of white patches, the surface of the tongue becomes smooth, red, and shining, giving rise to the condition known as the "*glazed red tongue.*" In other cases the growth of epithelium may be very excessive, forming thick scaly masses on the surface, from which this variety has been termed *ichthyosis of the tongue.* These forms, though differing in detail, are essentially the same pathologically.

All forms of the disease are accompanied by some discomfort, though usually no actual pain. The tongue is tender, so that the patient cannot take mustard, or spices, or drink hot fluids. The speech may become slightly lisping or indistinct. The duration is very indefinite. In some cases it progresses slowly for many years, at last becoming stationary and causing the patient but little inconvenience. In others ulceration may take place after a few years. The invasion of epithelioma may occur after ten or even twenty years, and in many cases the patient escapes altogether. The *causes* of the disease are not always to be clearly ascertained. The earlier writers believed it to be invariably an effect of syphilis, but there seems no doubt that this view cannot be maintained. A. E. Barker has paid great attention to this subject, and to his valuable article on the "Diseases of the Tongue" in Holmes's System of Surgery I would refer the reader for more detailed information than can be given here. He has collected from various sources 110 cases of chronic superficial glossitis. Of these, 101 occurred in males and 9 in females. Of the 101 cases in males, 55 affected the tongue only ; 33 the tongue and cheeks ; 12 the lips and cheeks ; 1 the hard palate, and in 4 the seat was not mentioned. Of the 110 patients, 33 had certainly had syphilis, and 19 certainly had not ; in the remaining cases it was doubtful. The fact that nearly one-third of the patients had suffered from syphilis would suggest that though not the sole cause, it may form an important element in the production of the disease. The disease was associated with psoriasis or eczema in 6 of Barker's cases, and with syphilitic psoriasis in 2. It has also been seen associated with ichthyosis of the skin. In 75 cases evidence was given as to some influence on the occurrence of the disease. Chronic dyspepsia and habitual spirit-drinking are also supposed to act as predisposing causes. That dyspepsia should take a part in its causation is not surprising, as it is well known to every smoker that the tongue becomes sore more readily when "the stomach is out of order."

The *Prognosis* is always bad as to cure. Of the 110 cases recorded by Barker the disease ended in epithelioma in 43. The average duration of the disease before this took place was 14 years. Such cases must be carefully watched for the earlier signs of the invasion of epithelioma, as by early removal the disease might possibly be cured.

The *Treatment* is not usually very satisfactory. If there is any evidence of syphilis, the patient must be treated for that disease. Smoking, the use of hot spirits and hot condiments must be prohibited. In some cases, where there is a tendency to scaliness, arsenic is of use. Locally, before ulceration has taken place, Barker recommends frequent washing of the mouth with a solution of bicarbonate of soda (gr. xx. to ℥j). In a more advanced stage Joseph states that he has found daily rubbing of the surface with a concentrated solution of lactic acid of great use. A weak solution of chromic acid applied to the patches is said to have arrested their progress. When the surface tends to become warty, Ingals of Chicago recommends the application of the galvanic cautery. Strong chemical caustics usually aggravate the disease. If simple ulceration has taken place a solution of bichloride of mercury (gr. ij. to ℥j.) applied to the dried tongue with a camel's-hair pencil twice a day will often be found extremely useful. Its chief value is as an antiseptic, as the surface of the ulcer is apt to become very foul.

Other Superficial Affections of the Tongue.—Various other superficial affections of the tongue are commonly met with. The small tender whitish patches or **aphthæ** met with so commonly as the result of dyspepsia and **thrush** belong rather to medicine than to surgery, and need not be described here. A peculiar wandering rash which has been described under the name of "**lichenoid of the tongue**" by Gubler, has been called attention to by Barker in this country, who suggested for it the name of "**annulus migrans**." It is characterized by the appearance on the tongue of small circlets or crescentic bands of light-coloured rash, which rapidly spread centrifugally over the tongue. It causes some salivation and itching. It is not apparently due to the presence of a parasite. The disease runs a chronic course, and no treatment seems to have any effect upon it.

Simple Ulceration is not uncommonly met with upon the side of the tongue usually opposite the molar teeth, most commonly dependent on irritation of sharp projecting stumps. These ulcers cause considerable pain in eating and speaking; they are red on the surface, with slightly raised but not everted edges, and the base is free from induration. They are thus easily distinguished from epithelioma. They readily heal if the offending tooth is filed, stopped, or removed.

Tubercular Ulcer of the Tongue.—Tubercular ulceration of the tongue was first noticed by Portal, and has been since accurately described by Raynaud and Nedopil and others. It is not common, but occurs with sufficient appear round about, and the sores thus formed may coalesce, forming a larger irregular ulcer, with a yellowish, uneven surface, and slightly indurated base. They occur usually at the anterior part of the tongue at the edges or on the under surface, very rarely on the dorsum. They are extremely painful. These ulcers commonly appear in advanced pulmonary phthisis, but may occur before the lung-symptoms become marked. Nedopil has microscopically demonstrated the presence of tubercle in these sores. In a case under the care of Godlee, the tubercle-bacillus was detected in the base of the ulcer. In another, recorded by Boyd, it was not found. The treatment consists in the application of morphia and glycerine to relieve the pain. If the patient is in a state to stand an operation the sore may be scraped with a sharp spoon and dressed with iodoform, or the whole sore may be dissected out. If the soreness is so great that the patient cannot take food, the surface must be painted before each meal with a 20 per cent. solution of cocaine.

Syphilitic Affections of the Tongue.—The following are the chief syphilitic affections met with in the tongue: *primary sores* (Vol. I., p. 1122), these are very rare and present nothing peculiar; in the early secondary stage *papules* are not uncommon; later on *small superficial ulcers* may occur; and later still *fissures* with thickened epithelium around them may be met with; *mucous tubercles* are more rare. In the tertiary stage the patient may suffer from fissures and superficial ulcers similar to those already mentioned, from *chronic superficial glossitis* with leucoplakia, from *diffuse induration* of the organ, and from *gummata*. These have already been described in the chapter on Syphilis (Vol. I., p. 1146), and the gummata alone need be further referred to here.

Syphilitic Gummata are not uncommon in the tongue. A gumma forms an irregular indurated mass imperfectly circumscribed, and of rounded shape situated in the substance of the organ. It may occur at any part of the tongue, but it is perhaps most frequently met with near the dorsum, sometimes in the middle line, a situation in which epithelioma is very rarely found. It commences distinctly beneath the surface, the mucous membrane covering it being at first unaltered. As it approaches the surface the mucous membrane becomes adherent to it, and dusky red in colour. Under proper treatment the growth may disappear, but frequently it softens; the mucous membrane over it then gives way and a ragged cavity is exposed, in which the remains of the gumma are seen as an adherent slough, resembling wet wash-leather in appearance. If the gumma is watched from the beginning, and presents the typical course and appearances above described, there can be little difficulty in its diagnosis. If, however, it be seen for the first time after the characteristic slough has separated, the foul cavity that is left may closely resemble an epithelioma. If there is any doubt a piece of the floor or edge of the ulcer may be removed and examined microscopically, when the true nature of the disease can usually be determined. The *Treatment* consists in the administration of large doses of iodide of potassium, and if that produces no effect mercury may be given. If the gumma softens and ulcerates the same constitutional treatment must be continued and the sore dressed with iodoform.

Tumours of the Tongue.—**Papillomata.**—Small warts are sometimes epithelioma may assume this form, or if the growth is at first simple it tends soon to become malignant.

Nævus and Aneurism by Anastomosis are but rarely seen in the tongue, and when met with would require to be treated on the same principles that guide us in the management of the disease elsewhere. A very remarkable instance of an erectile tumour of nævoid character affecting the tongue came under my care, in which the whole of the free extremity of the organ was implicated in the morbid growth, presenting a club-shaped end, which protruded between the teeth and lips of the patient, a girl about three years old. In this case Image, of Bury St. Edmunds, had arrested the disease, and produced consolidation of the mass, by the introduction of setons, which were worn for some months; and, when the child subsequently came under my care, the chief inconvenience that existed resulted from interference with speech, and the deformity occasioned by the hypertrophied and elongated organ. By means of the écraseur I removed all the redundant tissues, and so reduced the tongue to its normal length and breadth.

A form of very vascular local hypertrophy may occur in the tongue at a later period of life, which may perhaps be best classed with these growths. The case of which Fig. 739 is a good representation was of this kind. It occurred in a lady about 50 years of age. The disease was confined to the anterior half of the tongue, which I successfully removed with the écraseur.

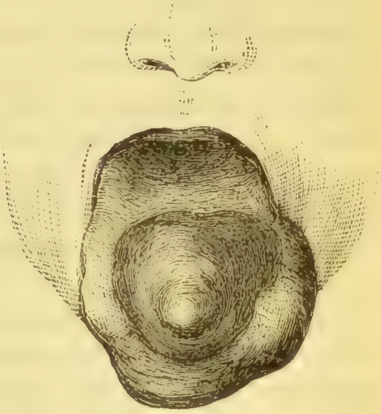


Fig. 739.—Vascular Hypertrophy of Tongue.

Cystic Tumours of the Tongue.—Two forms of cyst have been met with in the tongue, *hydatids*, which are extremely rare, and *mucous cysts.*

Mucous Cysts seldom reach any large size. They lie immediately beneath the mucous membrane, usually on the dorsum or at one side. They may be so tense as to resemble solid growths. Chronic abscesses which are occasionally found in the tongue cannot with certainty be distinguished from mucous cysts till the fluid has been let out by a puncture. The *treatment* of a mucous cyst consists in dissecting it out if possible. If this cannot be done it will usually suffice to puncture the cyst and apply a strong solution of chloride of zinc to the interior.

Fibrous Tumours have been met with in the tongue, but are extremely rare. Should such a growth be met with it may readily be removed by drawing the tongue forwards by means of a hook or piece of whipcord passed through its tip, and then dissecting it out. Any bleeding that occurs may be arrested by ligature, or by passing a suture by means of a curved or corkscrew needle across the gap in the course of the divided vessels, and thus closing the aperture at the same time that the vessels are compressed.

Cancer of the Tongue.—Squamous carcinoma or epithelioma is possibly from the sublingual gland. It is however so rare, that it need not be further considered in describing cancer of the tongue.

Epithelioma almost always commences on the edge, usually at the middle third, extending back to the anterior pillar of the fauces, but it may occur at the tip of the tongue, in the floor of the mouth, or, in rare cases, on the dorsum. It most usually occurs in individuals between the ages of 40 and 60. It is more frequent in men than in women ; according to Barker in the proportion of 247 to 46. It may develop without any evident cause in persons who are otherwise perfectly healthy, whose teeth are sound, and in whom there has been no pre-existing disease of the tongue ; but most commonly it occurs in consequence of local irritation, as from the abrasion produced by a broken tooth. In other cases, as before pointed out, it is preceded for some years by psoriasis or other chronic disease of the mucous membrane (p. 660). It may arise in an old syphilitic crack or unhealed fissure. If it appear in an otherwise healthy tongue, as a tubercle or warty growth, this is usually flat, indurated, and of a purplish-red colour, gradually running into ulceration ; if as a fissure, this from the commencement has an indurated base, a foul surface, and a callous edge. As the ulceration extends, a chasm with everted edges and ragged sides, and a sloughy surface that cannot be cleansed, gradually forms over a widely indurated base ; there are great fœtor of the breath, and profuse salivation ; and, as the disease progresses, implication of the mucous membrane and of the structures of the floor of the mouth, and of the glands under the jaw and in the neck, takes place. Sometimes the whole mass of the organ is infiltrated by the cancerous growth, becoming generally hard, nodulated, ulcerated, and in some parts covered by thin red cicatrices, and in others by foul putty-like accumulations of epithelium. The pain is very severe in most cases : every movement of the organ in articulation, mastication, or deglutition causes great suffering. The friction or compression by neighbouring teeth, the profuse salivation, all aggravate the patient's distress in this most agonizing disease. The pain is not confined to the tongue, but runs through all the branches of the fifth nerve over the side and crown of the head, to the face and the ear. The lymphatic glands under the jaw usually become involved at an early period ; though the disease may exist for a year or two without their becoming implicated. Cachexy at last supervenes, and the patient dies from the conjoined effects of exhaustion, irritation, starvation, and poisoning from the septic discharges.

There are three conditions in cancer of the tongue that are of serious import, and that may, singly or in conjunction, lead to a fatal termination. 1. The pain not only wears out the patient by depriving him of rest and comfort in life, but being greatly aggravated by mastication and deglutition, causes him to avoid these acts, and hence leads to a process of gradual starvation, either by his abstaining from food altogether, or taking a liquid and innutritious diet, because it is more easily swallowed than solid and more substantial meat. 2. The profuse salivation tends still further to exhaust the patient ; and 3. The occurrence of hæmorrhage, when the disease has eroded so deeply as to open up one of the larger branches or trunk of the lingual artery, may, by repeated recurrence or by sudden gush, destroy life.

patient dies by recurrence of the disease after removal, he has probably obtained some months of immunity from suffering. The fatal termination usually takes place from recurrence in the glands of the neck, secondary growths in the viscera being very rare, as in epithelioma of other parts. The enlarged cervical glands gradually reach the skin, soften, and break down, leaving foul cavities, and the patient gradually dies exhausted from pain, and poisoned by the absorption of the decomposing discharges. Sometimes the enlarged glands push into the pharynx, obstructing both deglutition and respiration. Still, as a rule, if recurrence in the mouth can be avoided, the mode of death is far easier than when due to the primary disease.

Diagnosis.—The diagnosis of epithelioma of the tongue in its advanced stages is usually easy enough ; the deep foul ulcer on one side of the tongue, the pain, the fixity of the organ and the enlargement of the lymphatic glands make the nature of the disease unmistakeable. At this period, however, little can be done to cure the patient or even to relieve him. To be of any service to the patient, the diagnosis must be made early, while the disease is still localized, and an operation can be undertaken with some prospect of giving lasting or permanent relief. *Syphilitic ulceration*, with an indurated base, commonly closely resembles cancer of the tongue : so closely, indeed, that it is only with great difficulty that the diagnosis can be effected. This, however, may generally be accomplished by observing that the syphilitic ulcer is elongated, irregular, does not rapidly extend, and is associated with other evidences of constitutional syphilis ; while the cancerous ulcer is of a more circular shape, has hard and everted edges, is more painful, and spreads with greater rapidity.

The diagnosis between the *syphilitic gumma* and *cancer* is most important ; here the duration of the disease and the co-existence of constitutional syphilis must be taken into account. It is also of much moment to attend to the mode of commencement and situation of the tumour ; the syphilitic gumma commences in the muscular substance of the tongue, and implicates the mucous membrane secondarily. Epithelioma is superficial, commencing in the mucous membrane, and secondarily implicating the deeper structures. It must, however, be remembered that a tongue which has long been the seat of those morbid changes in the way of thickening of its epithelium and ulceration of its mucous membrane, which are common sequelæ of syphilis, may at length become affected by true epithelioma.

In the case of a doubtful ulcer the Surgeon must not wait till the nature of the sore becomes evident by enlargement of the glands and extensive implication of surrounding parts, nor must he waste time in trying the effects of treatment by mercury or iodide of potassium. By so doing he may rob his patient of his only chance of cure. A portion of the ulcer should be at once removed by means of a sharp spoon or a pair of scissors, and submitted to microscopic examination. This may be done painlessly by applying a 20 per cent. solution of cocaine for a few minutes. If there should still be any doubt the ulcer should be cut out, for the removal of a small and superficial portion of the tongue is a most simple operation, and practically free from danger.

Treatment.—In the treatment of cancer of the tongue, medicines are cancerous infiltration often extends much farther than at first appears, passing deeply between the muscular fasciculi and planes, into the root of the tongue. In these deep cancerous affections there is usually great enlargement of the glands under the jaw, with infiltration of the floor of the mouth and neighbouring soft parts to such an extent as to render it impossible to excise or in any other way remove the whole of the disease.

There are two operations occasionally practised, having for their object to palliate the suffering or to retard the progress of the disease: viz., Division of the Gustatory Nerve, and Ligature of the Lingual Artery.

Division of the Sensory Nerve of the Tongue.—Section of the gustatory branch of the fifth nerve was first proposed and practised by Hilton, with the view of relieving the pain of the cancerous ulcer, retarding the progress of the disease, lessening the profuse salivation, and enabling the Surgeon to apply ligatures for the removal of the cancer to a part that has been deprived of all sensibility. This operation, which Moore repeated several times, undoubtedly accomplished the objects for which Hilton originally proposed and practised it; more especially so far as relief of pain and diminution of salivation are concerned. And it deserves to be considered as one of the most efficient modes of relief to the suffering produced by cancer of the tongue, in all cases in which removal of the disease is not practicable.

Division of the gustatory nerve may be done in two ways; one originally employed by Hilton, the other by Moore. Both operations consist in dividing the nerve in that part of its course which extends from its emergence between the internal pterygoid muscle and the jaw to the point where it enters the tongue. Opposite to the second molar tooth, the nerve lies under the mucous membrane of the floor of the mouth. There it can be easily reached by the division of the mucous membrane covering it, when it will be found close behind the sublingual gland. It may be raised by a blunt hook, seen, and divided. It was in this situation that Hilton practised its section. The advantage of this choice of place is, that the nerve can be seen and its division thus rendered certain. The disadvantages are, that the guides to the spot are not quite certain; that the cut is apt to be obscured by hæmorrhage; and that, when the disease has extended to the floor of the mouth, the operation is inapplicable. Moore consequently recommended, and in five cases practised, section of the nerve further back. The guide to it in this situation is the last molar tooth; and a line drawn from the middle of the crown of the tooth to the angle of the jaw will cross the nerve in the exact place where it should be cut. The nerve lies about half an inch from the tooth, between it and the anterior pillar of the fauces, parallel to but behind and below the bulging alveolar ridge, which can be felt in the lower jaw ascending towards the thin coronoid process. By entering the point of a knife, therefore, into the mucous membrane of the mouth, three-quarters of an inch behind and below the last molar tooth, and cutting down to the bone, the nerve must be divided. Moore advises that for this purpose a curved bistoury be used, as the projection of the alveolar ridge would protect the nerve from a straight blade. The good effect of the operation is instantaneous; pain ceases in the tongue, ear, face, and head, and the flow of saliva is diminished: and the relief is continuous, for it does not appear that the nerve re-unites.

Ligature of the Lingual Artery may be required to restrain profuse hæmorrhage from an ulcerated cancer of the tongue. This operation has been practised also with the view of starving the morbid growth and thus retarding its development. That it does so for a short period is undoubtedly the case, but that it does so permanently is a fallacy. This operation has been recommended for these purposes by Demarquay, and has been performed in this country by Moore and C. Heath.

The artery is reached with most certainty in the digastric triangle of the neck, where it lies beneath the hyo-glossus muscle. A curved incision carried from about one finger's breadth external to the symphysis menti downwards to the great cornu of the hyoid bone and prolonged upwards to near the angle of the jaw will expose the lower border of the submaxillary gland. In fat subjects, or when the parts are swollen, the incision must be of the full length above mentioned, but under ordinary circumstances it may be curtailed by about half an inch at each end. The first incision divides the skin, superficial fascia, and platysma, exposing the strong fascia covering the submaxillary gland. If the incision be carried too far back, the facial vein will be divided. The deep fascia must now be opened, and the submaxillary gland raised and drawn upwards towards the jaw. The tendon of the digastric then comes into view, and a space is exposed bounded below and externally by the curved tendon of the digastric, internally by the free edge of the mylo-hyoid, and above by the ninth nerve accompanied by a small vein. The floor of the space is formed by the part of the hyo-glossus arising from the great cornu of the hyoid bone. The fibres of the hyo-glossus must now be picked up carefully in this space, and divided horizontally, when the lingual artery will come at once into view (Fig. 740). Care must be taken while exposing the artery not to cut too deeply, as it is separated from the mucous membrane of the pharynx merely by a few fibres of the middle constrictor. Sometimes the stylo-hyoid ligament comes into view; it may be recognized at once by its passing upwards and outwards, while the artery is directed upwards and inwards. Should it be seen it may be used as a guide to the artery which passes between it and the hyo-glossus. In rare cases the artery lies with the

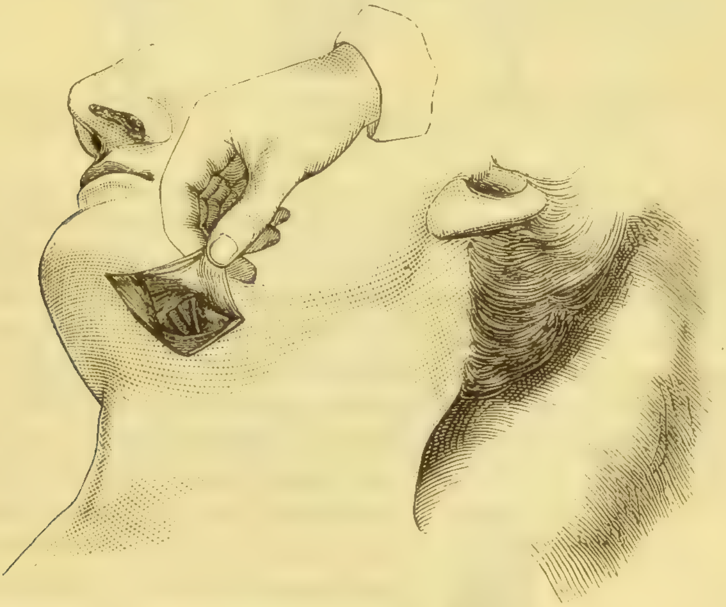


Fig. 740.—Ligature of Lingual Artery.

ninth nerve superficial to the hyo-glossus, in which situation it must be sought if not found in its proper place.

Operations on the Tongue.—The operations that are practised on the tongue when it is affected by cancer consist in removal of a portion of the organ only, or its complete extirpation from the hyoid bone according to the situation of the disease and the extent to which the tongue is implicated. Unless the disease can be very fully and freely extirpated, it is better not to attempt any operation, for in no organ is there a greater tendency to recurrence of cancer than in the tongue. When the disease extends to the floor of the mouth, implicates the arches of the palate, or has largely infiltrated the submaxillary lymphatic glands, the propriety of operating becomes very doubtful. Even under these circumstances, however, extensive operations have been performed with at least temporary benefit in some cases. In determining the question of operating, much will depend upon the condition of the patient. If he be otherwise in good health, though suffering greatly from the pain of the cancer, and if the secondary affection be limited to the glands below the jaw, which can be removed without difficulty, an operation may be undertaken. If he be greatly exhausted by pain and want of food, and more especially if the glands under the sterno-mastoid are enlarged, an operation would at the best give very temporary relief, and would be very likely to be directly fatal.

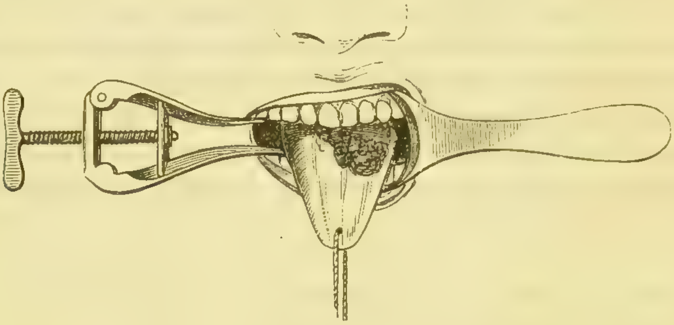


Fig. 741.—Application of Screw-Gag, Cheek-Retractor, and Whipcord, in Operations on the Tongue.

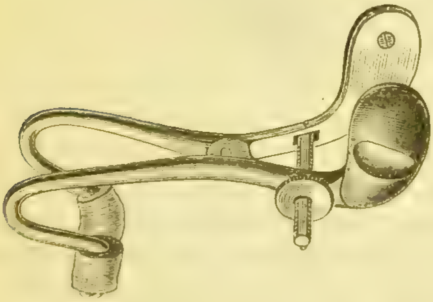


Fig. 742.—Fergusson's Gag.

In all operations upon the tongue, the organ must be thoroughly exposed and kept well under control during the performance. The first object is attained by means of an efficient gag. The screw-gag (Fig. 741) may be used in some cases, but it is rather apt to slip. Fergusson's (Fig. 742) or Langenbeck's (Fig. 743) gag will be found more efficient. Fergusson's is very difficult to keep in position when the back teeth are wanting, as it tends to slip forwards. Langenbeck's gag may then be of service, but it also is uncertain if the front teeth are wanting. Efficient gagging is one of the most essential parts of all operations on the tongue, and in every case it is better to entrust the gag to an assistant, whose sole duty shall be to see that it does not slip. The slipping of the gag and the sudden closure of the mouth at a critical point in the operation may necessitate a sudden performance of laryngotomy, or may even cost the patient his life. If the patient be efficiently gagged the jet of blood from a divided lingual will usually be thrown out of the mouth, and cause but little trouble. If a gag be used which acts on one side only, the tongue must be fully exposed by a cheek-retractor (Fig. 741) applied on the opposite side. During the operation the tongue must be controlled by a strong whipcord ligature passed through it about an inch from its tip. If only a small portion of the anterior part is to be removed, a single thread will suffice. In removing half the tongue two ligatures must be passed, one on each side of the middle line, so as to control not only the part to be removed, but the remaining part also, so that the stump may be drawn forwards at the end of the operation to arrest hæmorrhage. When a portion only of the tongue is to be removed it may be done by the écraseur, the knife, or the scissors.

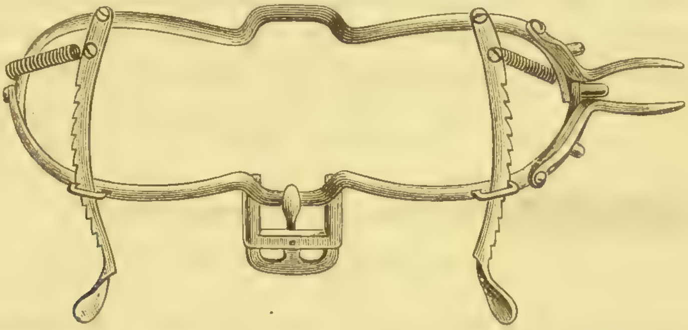


Fig. 743.—Langenbeck's Gag.

For the purposes of operation the tongue may be divided into three regions; viz., the anterior third, the central lateral portion, and the posterior part.

Excision of a small part of the Tongue may readily and safely be done when the free anterior portion only is diseased, or when it is only superficially affected at its side or back part. The patient having been gagged the tongue is secured by passing a thread through it. It is then drawn well forward while the lingual artery is compressed in the way recommended by C. Heath. To do this the forefinger is passed over the dorsum of the tongue till it touches the epiglottis; it is then turned towards the side on which the artery is to be compressed, and hooked forcibly upwards against the jaw. The diseased portion of the tongue is then cut out with scissors. If the artery be well compressed the operation will be practically bloodless. On removing the

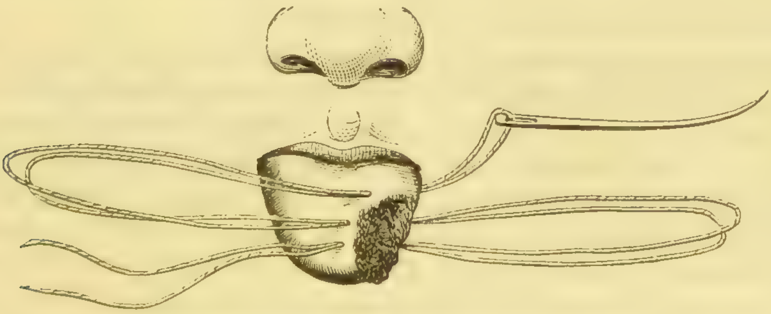


Fig. 744.—Application of Ligature to Cancer of Anterior Part of Tongue.

pressure the hæmorrhage is free, often profuse, but the larger vessels are seized in forcipressure forceps, and twisted or ligatured, and the oozing will soon cease on the application of ice.

Strangulation of the diseased mass by means of the *Ligature* was a mode of operating formerly practised when the means of controlling and arresting hæmorrhage were less perfect than they are now. It was extremely painful, and caused great discomfort from the presence of the fœtid mass in the mouth, and was, moreover, frequently fatal from septicæmia. It is now completely abandoned. The ligature was passed by an ordinary nævus-needle and a corkscrew-needle (Fig. 745), or a common needle, according to circumstances, and the mass strangulated in the same way as in ligature of a cutaneous nævus. Cloquet, Arnott, and others even ventured to strangulate the whole tongue by ligatures passed through an incision in the hyoid region, but such operations were rarely successful.

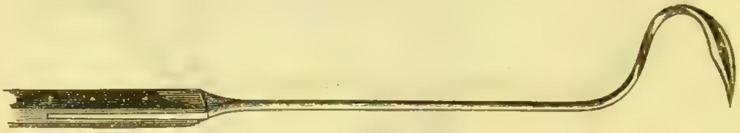


Fig. 745.—Corkscrew-Needle.

Excision of the Whole or of a Large Portion of the Tongue.—This operation may be performed in four ways. 1. From the inside of the mouth, without any external incisions. 2. By the submental method, through the mylo-hyoid space. 3. By the buccal method, a free incision being made through the cheek; and 4. By division of the lower lip and jaw.

The excision of the whole tongue *from the interior of the mouth* was rarely performed until the fear of hæmorrhage during the operation was practically removed by the introduction of the écraseur by Chassaignac. At the present time the means of gagging the mouth and of arresting the hæmorrhage during the operation being more perfect, the écraseur is not so extensively used as formerly, the tongue being more frequently removed with the scissors in the way first recommended by Whitehead.

Excision by the Écraseur is carried out in various ways, of which the following is one commonly adopted. The gag having been applied, the end of the tongue should be secured with a piece of whipcord and well drawn forwards and upwards. The Surgeon then cuts across the frænum by means of strong curved scissors, and divides successively the insertions of the genio-hyoid and genio-hyo-glossal muscles into the lower jaw, cutting freely backwards so as to liberate the base of the tongue. He now snips across the reflexion of the mucous membrane of the floor of the mouth from the lower jaw, and then, laying aside the scissors, separates widely with his fingers the base of the tongue from these parts. As he does this the assistant, who has charge of the whipcord ligature, draws the tongue well forwards, and it comes bodily out between the lips. If the anterior pillar of the fauces offer any obstacle it may be snipped across, and the wire of the écraseur may then be applied well round the back of the organ, the shaft being pressed up under the base of the tongue. If the wire have a tendency to slip forwards, a large double hook should be passed in front of it into the base of the tongue, so as to steady it and prevent its slipping. By now working it gradually, the whole organ can be removed.

In this as in all other methods of removing the tongue, it must be remembered that if the attachments of the genio-hyoid and genio-hyo-glossus muscles have been completely divided there is a tendency for the stump of the tongue to fall backwards into the pharynx, and thus, if it is of sufficient size, to cause asphyxia. This must be guarded against by passing a thread through it and drawing it forwards. If necessary the thread must be attached to the teeth or drawn forwards and fixed to the cheek by plaster.

Nunneley, of Leeds, devised an ingenious mode of applying the écraseur so as to remove portions of the tongue, or, indeed, the whole organ, as far back as the hyoid bone. This operation consists in passing the chain of the écraseur through the centre of the mylo-hyoid space by means of a sickle-shaped needle, about 4½ inches long and as broad as a bistoury blade. By this needle the chain is brought into the mouth close to the frænum. Two or three curved and strong hare-lip pins are now passed deeply into the tongue, obliquely, behind the seat of the disease, their points being made to project forwards below the organ, so as to prevent the chain from slipping. The loop is now gradually tightened, and the tongue is cut off obliquely from behind forwards.

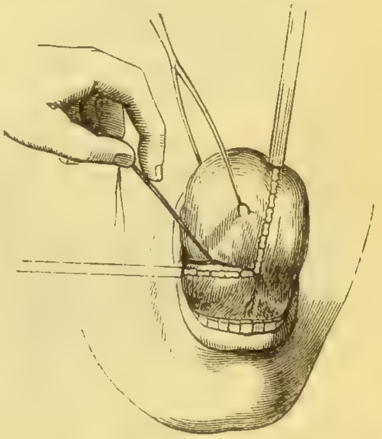


Fig. 746.—Two Écraseurs applied to Cancer of Tongue.

Two *écraseurs* were successfully used by Chassaignac in removing portions of the tongue. When the disease occupies only one side, and it is not thought necessary to cut away the whole breadth of the organ, two instruments are required, which, as Chassaignac represents (Fig. 746), must be passed through the substance of the tongue in opposite directions, so as to isolate and detach the diseased portion. The operation may, however, be performed much more rapidly and easily by splitting the tongue in the middle line by means of a knife or a pair of scissors. As Morrant Baker has specially pointed out, an incision, if made accurately in the middle line, is almost bloodless. The incision can be safely carried backwards as far as the root of the tongue, and the separation of the diseased half of the organ and the application of the écraseur are much facilitated by so doing.

The following points must be attended to in removing large portions of the tongue by means of the écraseur. The wire should be thick. If too thin it cuts almost as readily as a knife, and the lingual arteries will certainly spout and require a ligature. The instrument should be worked very slowly, in order that time may be given for the vessels to contract.

The wire écraseur (Fig. 747) will be found better than the chain-instrument. The form of wire best suited to the instrument is strong piano-wire. It will be found better to attach one end only to the movable part of the instrument, the other being twisted round the handle, as in the figure. It then cuts by a slow sawing movement and divides the vessels more surely. Middeldorpf's galvanic cautery was much used a few years ago in operations on the tongue (Fig. 748). By working this slowly, and not heating the platinum-wire beyond a red heat, the tongue may be removed without the loss of a drop of blood. This I have done in several cases in which the whole tongue required removal, from the inside of the mouth, without any external wound. The galvanic cautery cuts more rapidly than the ordinary instrument, and it was at first hoped that its use would considerably simplify the operation. Experience has, however, shown that the charred surface left by the passage of the hot wire, heals more slowly, with more discharge and sloughing than that left by the écraseur. Secondary hæmorrhage has occurred moreover in a considerable number of cases after its use. It was urged as another advantage attending its employment, that a charred surface offers a barrier to the absorption of septic matter, but the fallacy of this idea has been demonstrated by experimental investigations on animals. The instrument has therefore been abandoned almost universally, most Surgeons preferring the wire écraseur in those cases in which the scissors or knife cannot be safely employed.

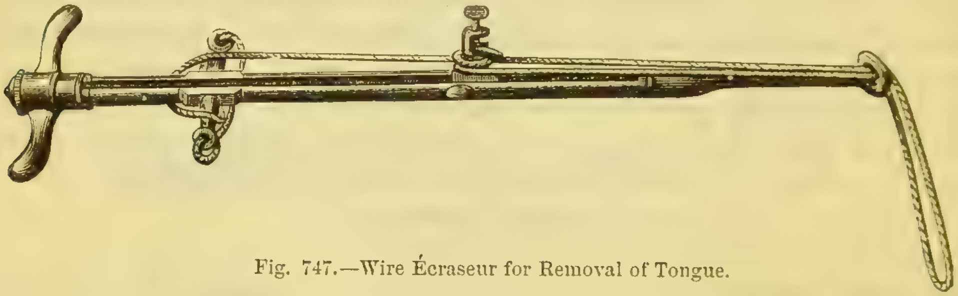


Fig. 747.—Wire Écraseur for Removal of Tongue.

In 1877, W. Whitehead of Manchester successfully removed the whole tongue through the mouth with scissors, and since then the operation has been repeated in a large number of cases with excellent results. The operation is conducted as follows. The mouth is efficiently gagged, and a double ligature passed through the tip of the tongue. The assistant in charge of this is directed to maintain throughout the operation a steady traction upwards and forwards. The operator commences by dividing all the attachments of the tongue to the jaw and to the pillars of the fauces with an ordinary pair of straight scissors. The muscles attached to the base of the tongue are then cut across by a series of *successive short snips* of the scissors, until the entire tongue is separated in the plane of the inferior border of the lower jaw as far back as the safety of the epiglottis will permit. Any vessels which bleed freely are seized in forcipressure forceps and twisted as divided, but a moment's pressure with a small piece of sponge, held in sponge-forceps, suffices temporarily, if not permanently, to arrest most of the bleeding. A single loop of silk is then passed by a long needle through the remains of the glosso-epiglottidean fold of mucous membrane, as a means of drawing forwards the floor of the mouth should secondary hæmorrhage take place. This may be

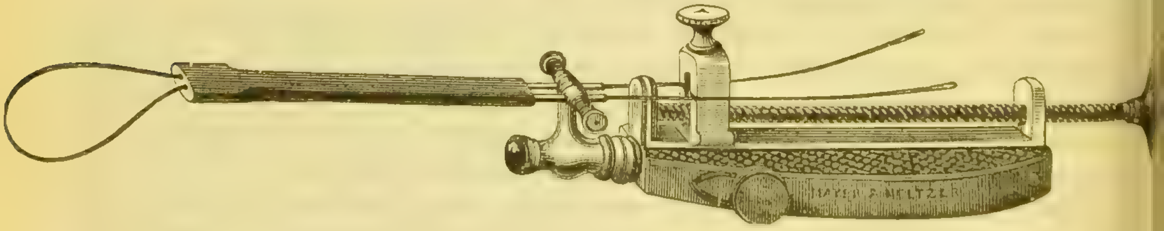


Fig. 748.—Galvanic Écraseur.

withdrawn on the second day. The hæmorrhage in this method of operating is much less than would be expected. Whitehead states that in two cases he removed the whole tongue without twisting a single vessel; this, however, is quite exceptional. In most cases the linguals and a few smaller vessels require torsion. In a paper read before the International Medical Congress of 1881, Whitehead recorded twenty-eight cases in which the operation had been performed with only three deaths, two of which occurred at a remote period after the operation.

If only half the tongue is affected it may be removed by scissors in the same way, after having been split in the middle line.

When the floor of the mouth is implicated, no operation through the mouth should be attempted; as it is impossible by this means to extirpate the whole of the disease in this situation, and partial removal of it will be followed only by rapid recurrence and increased activity of development. Slight enlargement of the glands under the jaw should not be any bar to the operation, provided the disease be limited, and the constitution good. If not too much enlarged, the glands may be excised at the same time with the disease of the tongue; or if they be so slightly enlarged as to be scarcely recognizable, they may be left, when they will perhaps subside without the necessity of operation, as their enlargement may possibly be dependent upon simple irritation; should they continue indurated, they may readily be removed at a subsequent period.

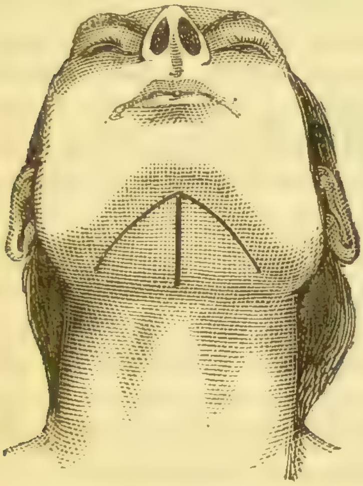


Fig. 749.—Lines of Incision in Regnoli's Operation.

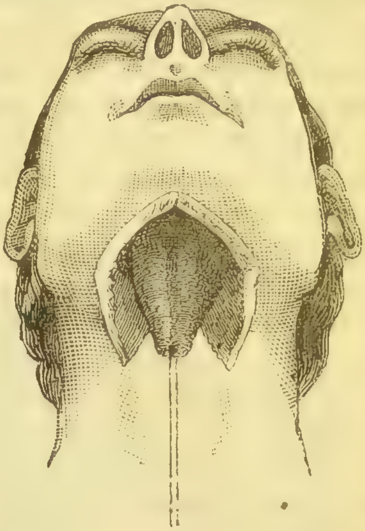


Fig. 750.—Tongue drawn out between Jaw and Hyoid Bone.

Submental Operation for Excision of Tongue.—Regnoli of Pisa published, in 1838, a description of the following method by which the whole tongue can be removed. An incision of a semilunar shape is made along the line of the lower jaw, beginning near one angle and terminating close to the other. A perpendicular incision is carried from the centre of this line immediately under the chin to the hyoid bone (Fig. 749). In making this semilunar incision, care must be taken not to wound the facial artery on either side. The trunk of the vessel should be protected by the finger of an assistant as it curves round the lower jaw, and the incision should be confined within the space between the two facials. The triangular flaps of skin formed in the manner indicated are dissected back, and the muscles and mylo-hyoid space are now exposed. These must be successively divided; the anterior bellies of the digastrics are cut across, the mylo-hyoid muscle divided transversely at its anterior part; and the attachments of the genio-hyoidei and genio-hyo-glossi are then to be detached from the lower jaw by a few touches of the scalpel, and by separating with the fingers the mucous membrane of the floor of the mouth. An aperture is then made into this by pushing the scalpel through it, and its reflexion from the inside of the lower jaw is divided as far back as the outer angles of the external incision. The submaxillary glands are pushed aside, and the tip of the tongue being seized with a strong hook or vulsellum-forceps, the organ is drawn out to its full extent on to the anterior part of the neck, between the jaw and the hyoid bone (Fig. 750), when the whole of it may be removed close to its attachments to the latter bone by means of the scissors or the écraseur. If the écraseur be used, it will occasionally be found that the anterior pillar of the fauces is somewhat in the way of the application of the instrument. Should this be inconveniently so, it may be snipped across before the wire is applied. By means of this operation, which I have several times performed, the whole of the tongue may be shaved off clean from the base of the epiglottis and hyoid bone. After the removal of the tongue the hæmorrhage will usually be found to be trifling; but should one or other of the lingual arteries bleed, it may readily be seized and twisted. The incision in the skin must then be stitched up, a drainage-tube being inserted at the lower end of the vertical incision.

Kocher of Berne, believing that the best hope of giving prolonged relief or possibly permanently curing the patient, lies in a complete removal in every case of the lymphatic glands below the jaw simultaneously with the diseased part of the tongue, has introduced a method of operating which in his hands has been attended by a considerable degree of success. He makes a free external incision, commencing a little below the lobule of the ear and running downwards along the anterior border of the sterno-mastoid to the level of the great cornu of the hyoid bone; from this an incision is carried forwards nearly to the body of the hyoid bone, and then upwards along the line of the anterior belly of the digastric to the jaw. The flap thus marked out is turned upwards over the face. The lingual artery is then tied before it passes beneath the hyo-glossus. By a process of careful dissection, all the lymphatic glands are removed from the region exposed by the wound. In so doing the carotid sheath will be exposed, as one gland always lies upon it close to the sterno-mastoid. The facial artery and vein will be divided, and must be secured by ligature. It is necessary to remove the submaxillary and sublingual glands, which otherwise are much in the way. Some lymphatic glands, touching the inner surface of the jaw, between it and the sublingual gland, must be sought for and removed. The mylo-hyoid muscle and the mucous membrane of the mouth are now fully exposed, and must be carefully divided when the side of the tongue to its very root comes into view. If only one side is affected, the tongue may now be split down the middle line from the mouth, and the base cut through from the external wound. Kocher recommends a preliminary tracheotomy and plugging the pharynx during the operation. In 14 cases operated on by himself by this method only one patient died, from secondary hæmorrhage from the tracheotomy wound. In 8 recurrence of the disease took place, 1 died a year after of pneumonia, and 4 remained well at 14 months, 5, 5 and 6½ years after the operation. The operation is a bold one, and requires skill and patience in its performance ; but the danger does not seem to be great, and the results are such as to encourage further attempts in the same direction.

The Buccal Operation.—Furneaux Jordan has introduced an operation which consists in dividing the cheek on the affected side backwards as far as the ramus of the jaw, care being taken to go below the parotid duct. The tongue is then seized in the usual way, and cut off by two écraseurs worked simultaneously, the chain of one dividing the organ transversely close to the pillars of the fauces, that of the other severing the tissues along the floor of the mouth. I have performed this operation in one case of unilateral cancer of the tongue, and found that the organ could readily be reached, commanded, and a portion removed through the gap in the cheek. After the operation is concluded, this is closed by sutures.

Excision of Tongue after Division of the Lower Jaw.—Sédillot of Strasburg described, in 1855, a method of removing the whole of the tongue, which he stated that he had practised for some years with success. The operation consists in making a vertical section through the lower lip, sawing through the inferior maxilla at its symphysis, separating the bone on each side, drawing the tongue forward and removing it. In performing this operation, its inventor recommends that the section of the lower lip should be made carefully through the median line, and carried across the chin as far down as the hyoid bone. The lower jaw is then sawn through at its symphysis. In order to fix the bone more accurately after the operation, he recommends that, instead of making one vertical incision, two oblique cuts should be practised with the saw in this shape >, so as to form a triangle, the point of which corresponds to the middle of the body of the bone, so that the two opposite sides may be locked together after the removal of the tongue. Before sawing the bone it may be drilled on each side half an inch from the edge of the intended incision through it. After having divided the lower jaw, the muscles connecting it to the tongue should be cut across and the mucous membrane forming the floor of the mouth detached from the bone, the two sides of which are drawn asunder ; and the tongue then removed from the hyoid bone by being gradually snipped through with scissors. The lingual arteries bleed freely, and must be at once secured. The opposite sides of the jaw-bone are then brought together, and held in position by wire twisted round the teeth, or passed through a hole drilled on each side before the

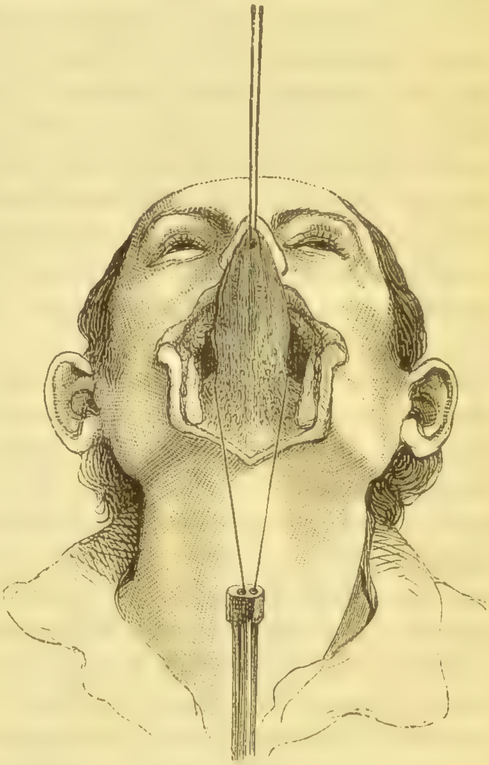


Fig. 751.—Removal of Tongue by Division of Lower Jaw and Ecraseur.

division of the bone. If Sédillot's angular cut be adopted, the bone may be kept *in situ* much more easily than if the vertical incision to which he first of all had recourse, and which is commonly adopted in this country, be practised. The incision in the lower lip must be united in the usual way by hare-lip pins or sutures. This operation was first done in this country by Syme and Nunneley, and has of late years been very extensively practised by many Surgeons. By it the whole tongue can be freely exposed and cut out from its deepest attachments. If it be preferred, the écraseur may be applied when the tongue has been fully exposed (Fig. 751). When the disease has commenced in the floor of the mouth and implicated the bone, the affected portion may be removed with the tongue. This has been successfully done by Heath, Barker, and others.

Hæmorrhage during Excision of the Tongue is the only serious danger of the operation, and so long as the mouth is thoroughly gagged even this need cause no anxiety. If only a part of the tongue is being removed, hæmorrhage may be immediately arrested by drawing the tip well out of the mouth by the ligature through it and compressing the lingual against the jaw by the method already described. The pharynx must then be thoroughly cleaned with sponges on sponge-holders. When this is done the assistant relaxes his finger, and the bleeding point can usually be seized without difficulty in a pair of forcipressure forceps. If the whole tongue have been removed, the stump must be hooked forward with the fore-finger and seized in a pair of vulsellum forceps while the artery is compressed as before described. Torsion is the most satisfactory mode of arresting the bleeding. The twisted end of the vessel becomes buried in the tissues of the stump of the tongue and secondary hæmorrhage rarely, if ever, occurs. If the attempts at torsion fail, a ligature may be applied and cut short. The most serious accident is when the gag slips while free hæmorrhage is going on. In a case of this kind I had to perform laryngotomy, as a coagulum formed in the pharynx before the vessel could be secured. The patient made a good recovery, dying two years after the operation from the recurrence in the lung and in one of the toes. Oozing of blood may usually be arrested by ice, or if it be more than usually free the bleeding point may be touched with Paquelin's cautery or perchloride of iron, but this should be avoided if possible, as it interferes with the healing of the wound. If very free hæmorrhage is expected it may be advisable in some cases to perform a preliminary tracheotomy and to introduce Trendelenburg's obturator or to plug the pharynx with a sponge.

After-Treatment.—As soon as all bleeding is arrested the stump of the tongue should be freely sponged with a solution of chloride of zinc (gr. 40 to ℥j), care being taken that none of the solution runs down the throat. This whitens the surface but in no way interferes with healing. Iodoform in fine crystals should then be gently rubbed into the raw surface with the finger. Whitehead recommends the application of a "varnish" composed of the same constituents as Friar's Balsam, the spirit, however, being replaced by a concentrated solution of iodoform in ether. The chief trouble in the subsequent treatment is to keep the mouth free from decomposing discharges. Various means have been tried for this, chlorinated gargles, sanitas, terebene, Condy's fluid, &c., but nothing approaches iodoform in efficiency. It should be applied daily in the form of crystals (not precipitated), a small quantity being sprinkled over the raw surface by means of a camel's-hair pencil. Whitehead recommends the daily application of his varnish. The mouth may be washed at intervals after the first thirty-six hours with a weak solution of permanganate of potash. Ice may be sucked at intervals for the first few days, if it be found grateful to the patient. A tendency to dyspnœa is sometimes manifested after the operation, owing to the stump of the tongue falling backwards. This is remedied by opening the mouth and drawing the stump forwards. If it occurs frequently a thread must be passed through the stump and retained for a few days. If only a part of the tongue have been removed the patient will be able to swallow fairly well after the first few hours, but if the whole organ have been taken away he must be fed through an india-rubber tube passed down the œsophagus for the first four or five days. The constant passage of the tube is a great source of pain and annoyance to the patient, and it will, as a rule, be found better to pass the tube half way down the œsophagus at the time of the operation, and to bring it out at the mouth (or through the wound in Kocher's operation), and to fix it there. This is best done by bringing the tube up the side of the face above the ear and applying a bandage to keep it in position. There is often trouble from profuse salivation for two or three weeks, owing to the patient being unable to swallow the viscid saliva excreted from the wounded and irritated glands. This is best controlled by alum gargles.

Accidents after the Operation.—Secondary hæmorrhage may occur about the fifth or sixth day, especially after the galvanic cautery. It rarely, if ever, follows excision by the scissors with torsion of the vessels. The free use of ice or a spray douche of ice-cold water may arrest it if it be slight. If free and arterial, perchloride of iron or the actual cautery may be required. If this fail the lingual may be ligatured above the hyoid bone unless that has been already done as a preliminary step to the operation. *Septic fever*, *septic poisoning*, *and septic infection* are prevented by avoiding whenever possible those methods of operating which leave a sloughing surface, and by the free use of iodoform in the after-treatment. *Septic pneumonia* due to the inhalation of decomposing matter from the floor of the mouth is a common cause of death in excision of the tongue, as in cut-throat and similar injuries. It is characterized by scattered patches of broncho-pneumonia, rapidly ending in breaking down of the lung-tissue. Sometimes, apparently by extension from these centres, large areas of lung-tissue may become gangrenous. This very fatal complication is best avoided by the use of iodoform and by drainage from the floor of the mouth in cases of removal of the entire tongue. A. E. Barker suggested and successfully practised in several cases a preliminary tracheotomy. After the operation the patient was made to breathe by the tracheal opening until the mouth had become clean. The introduction of iodoform has, however, so efficiently prevented septic processes in these cases that tracheotomy is now rarely required.

Comparison of the Methods of Operating.—In instituting a comparison between the different methods of dealing with cancer of the tongue it should be understood that the same plan of treatment is not equally applicable to all cases, but that one or other should be adopted according to the size, situation and extent of the cancerous mass. If this be small and situated at the tip, this portion of the organ may be easily and safely excised. If situated towards the side so as to require the removal of perhaps the anterior third of one side of the organ, it may be best done by splitting the tongue and excising the diseased part by the écraseur or scissors, and the same methods are equally applicable when half the organ has to be removed. If the posterior part be superficially affected the disease may be cut out and the buccal operation will then, in some cases, be found to expose the part most fully. If the organ be so deeply affected that the whole requires extirpation, it can be done from the mouth by the écraseur or by Whitehead's method. In some cases it will be found most convenient to split the tongue and remove the halves separately. If the floor of the mouth is implicated, recourse must be had to Sédillot's operation of division of the lower lip and jaw in the middle line. If it is intended to remove the glands below the jaw, Kocher's method will be found the best. Whichever method be adopted, the sublingual gland should always be removed either with the tongue or by scissors after the main part of the disease has been taken away, as there are some small lymphatic glands buried in its substance which are often an early seat of recurrence of the disease.

With regard to the choice between the écraseur and the scissors it may be said that increasing experience shows clearly the great superiority of the latter. The écraseur tends to slip forward and so to leave some of the disease behind, it by no means certainly prevents hæmorrhage during the operation, and it leaves a crushed surface which heals less rapidly and from which secondary hæmorrhage is not unlikely to occur. By the use of the scissors the Surgeon can accurately cut beyond the limits of the disease. A clean cut surface is left which readily heals, and if the bleeding vessels are twisted, secondary hæmorrhage is very unlikely to follow. It requires, however, a skilled assistant on whom the Surgeon can rely to seize the bleeding vessels in the forcipressure forceps, and if one is not available it might be preferable to use the écraseur.

Results.—The prognosis in cancer of the tongue is always bad. Removal of the diseased organ in part or in whole may relieve for a time, but very rarely does more than this. The more acute the cancer, the more rapid will be its recurrence, either locally or in the glands. A. E. Barker, who has most carefully investigated this point, states that out of 170 cases collected from various sources he could only find 17 in which recurrence did not take place under one year ; and in the whole of medical literature he could meet with the record of only 42 cases in which the patient had remained free from recurrence for a sufficient length of time to justify the hope that he was permanently relieved of the disease. One of the most successful cases on record was operated on by C. Heath. The cancer was situated near the frænum, adhering to the jaw and extending upwards into the substance of the tongue. The whole incisor portion of the lower jaw and the anterior half of the tongue with the corresponding part of the floor of the mouth were removed in one piece. The patient was alive and in good health ten years after the operation.

The mortality directly from the operation though considerable, is not very high when the serious nature of the proceeding is considered.

Barker has collected 218 cases from various sources, and finds that the death rate is 16·9 per cent. It is satisfactory, however, to note that of late years it has considerably diminished. Thus, at University College Hospital, 38 cases were operated on between 1871 and 1881, of which 10 died ; 20 of these operations were performed before 1877, and of these 8 died, while of the 18 since that date only 2 died. The diminished death-rate seems to be due in part at least to the more successful prevention of decomposition by the use of iodoform. The records of excision of the tongue were at one time so unsatisfactory, that some Surgeons have doubted the propriety of performing the operation ; but when we remember the terrible fate of the patient if the disease be allowed to run its course, and that cases of apparent cure, although exceptional, are not unknown, there is no doubt that the operation is not only justifiable but advisable. The hope of improvement in the results seems to lie first in early recognition of the disease, so that it may be removed before the glands are affected, and secondly, if this period be passed, in free removal of the diseased organ with the whole of the lymphatic glands which receive lymph from it, if this be possible. The fact that epithelioma seldom recurs in the viscera encourages us to attempt the removal of the affected glands whenever their situation is such that the operation can be safely undertaken.

Effect of the Removal of the Tongue on Speech.—Although distinctness of articulation is necessarily affected for a time by these operations on the tongue, yet it is usually completely restored when only the anterior third or half is removed ; the tissue of the organ recovering its normal mobility with remarkable facility, and indeed appearing to possess a very considerable reparative power, and to be capable of reproduction to some extent. Even after removal of the whole of the tongue, the power of deglutition is preserved, and that of articulation, although at first somewhat imperfect, eventually returns, so that the patient is able to speak so distinctly that strangers would not be aware of the loss he had sustained. Amongst the tortures to which Christian martyrs were subjected in the early ages, and the punishments which have been inflicted on heretics, "cutting out the tongue" was one of the most barbarous. Martyrologists in describing this horrible mutilation have remarked with wonder, that, although it was practised with the view of depriving the sufferers of the power of speech, yet it often failed in its effect, and those who have been subjected to it were enabled to speak afterwards as plainly as before. This they have attributed to direct miraculous intervention. But, as modern Surgery has shown that the power of speech returns equally, whether a cancerous tongue have been extirpated by the knife of the Surgeon, or a heretical tongue by that of the executioner, we must look upon the return of speech rather as a physiological fact, than as a miracle specially wrought for the benefit of those mutilated in and for the propagation of the true faith.

DISEASES OF THE FLOOR OF THE MOUTH.—**Solid Tumours** are occasionally met with in this region, *Epithelioma* being the most common. *Adenoma* also in connection with the salivary glands may occur. Nævi also have been observed in this situation. These tumours require removal by irregular operations, varying according to the size and situation of the growth. For these proceedings no special directions can be given. In removing such tumours as these, when situated under or by the side of the tongue, the knife must necessarily be used with much caution. It must, however, be borne in mind that, if these growths cannot be reached from the inside of the mouth, they may be got at by incision through the mylo-hyoid region, where there is but a slight thickness of soft parts between the surface and the floor of the mouth.

Cystic Tumours in the Floor of the Mouth may occur under three forms: 1, Ranula; 2, Congenital Dermoid Cyst; and 3, Bursal Cysts.

1. **Ranula.**—A globular swelling, semi-transparent, evidently containing fluid, and often attaining the size of a walnut or a pigeon's egg, may be situated under the tongue, pushing this organ upwards and backwards, and consequently interfering with deglutition and speech (Fig. 752). The wall of the cyst is usually thin, with small vessels ramifying on it; its contents are glairy and unlike saliva. This form of ranula is usually said to be a dilatation of Wharton's duct; but there is no proof of the disease being of this nature, nor is it very easy to understand how so small a duct can be dilated to so large a size as is occasionally attained by these tumours, which seem, in some cases at least, rather to consist of independent cystic formations, such as commonly occur in connection with other secreting glands, and in other parts of the mouth. And this view of the case is strengthened by the fact that these globular cystic tumours containing glairy fluid may occur in the substance of the tongue itself, far away from any salivary duct.

Morrant Baker, who has investigated the connection between ranula and the Whartonian duct, finds that, in cases of ranula, Wharton's duct is quite free, without any alteration in size, and that saliva may be seen issuing from it. A probe passed into the duct is separated from the ranula by a thin membranous wall, showing clearly that the duct and the ranula do not communicate. I have, however, lately seen a case in which a ranula resulted from a wound of the floor of the mouth, in the situation of the Whartonian duct. The wound was caused by the accidental slipping of a pair of tooth-forceps during extraction of the first molar tooth. As the wound healed a ranula formed, the contents of which were thick and ropy, like the natural secretion of the submaxillary gland. It ultimately reached the size of a plover's egg. That this tumour was formed by an accumulation of the secretion of the submaxillary gland, there can be little doubt; but it is quite possible that the collection formed in the submucous tissue, and that it was not enclosed in an actual dilatation of the Whartonian duct.

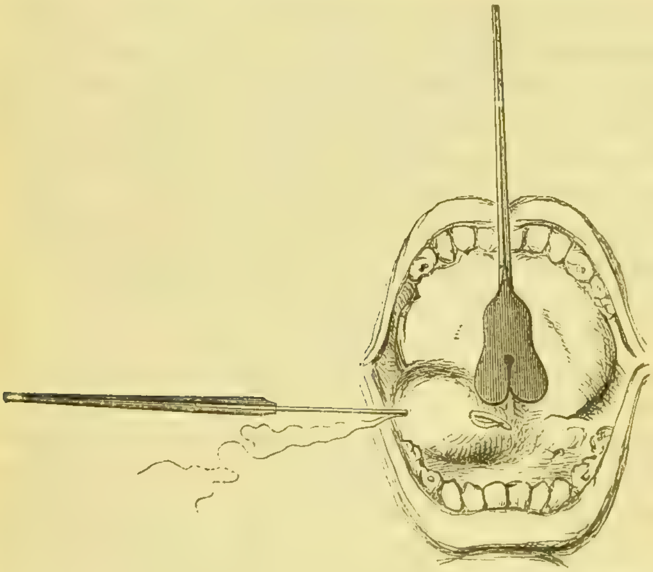


Fig. 752.—Ranula: Introduction of Seton.

The *Treatment* of this form of ranula consists either in passing a horse-hair seton through its walls, so that contraction may take place on this (Fig. 752); or else in the excision of a large portion of the anterior wall of the cyst, the remainder contracting until it at last becomes obliterated.

2. The **Congenital Dermoid Cyst.**—This rare form of cyst is met with in the middle line. It most commonly forms a swelling, projecting into the

mouth beneath the tongue, and also appearing on the neck. In a case of this kind under my care, the contents closely resembled cream-cheese in appearance, and were composed of epithelial scales and fatty matter (see also Vol. I., p. 1006). These cysts may be dissected out from the mouth or by an external incision in the middle line between the chin and the hyoid bone. The operation is troublesome, and may be accompanied by free bleeding.

3. **Bursal Cyst.**—This is believed to arise from enlargement of the bursa above the hyoid bone between the genio-hyoidei and genio-hyo-glossi. It projects usually more distinctly in the neck than into the mouth, and thus forms a large tumour, soft or elastic, and semi-fluctuating, occupying, perhaps, all the space between the symphysis and the hyoid bone. It may attain the size of an orange. The tumour is best treated by making a free incision into it, from the mouth if possible, and wiping out the cavity with chloride of zinc (gr. 40 to ℥j. of water), after which a drainage-tube may be inserted. If the tumour is more superficial externally the same treatment may be carried out from the outside. It is not possible in most cases to dissect the cyst out, as its wall is thin and its connections deep and important.

Salivary Calculi are occasionally met with in connection with the sublingual, submaxillary, and parotid glands. They are most common in the submaxillary gland, and will then be found to be situated in the Whartonian duct. From this situation I have two or three times removed them. Whereever occurring, they obstruct the duct and produce retention of saliva in it. Hence, when the salivary glands become actively secreting, as at meal-times, the calculus, by preventing the escape of the salivary fluid, causes distension of the gland, with pain and tenderness, rendering mastication difficult. Suppuration occasionally takes place round the calculus, and if it be in the submaxillary gland the pus may burrow downwards and point in the neck near the great cornu of the hyoid bone. This, however, is very rare.

The *Treatment* is simple. It consists in dividing the mucous membrane over the calculus and then extracting it with forceps. The largest which I have removed was of the size of a small damson-stone; it was loose in Wharton's duct.

DISEASES OF THE PALATE, UVULA, AND TONSILS.

HARD PALATE.—The hard palate is liable to *necrosis*, usually the result of syphilis or scrofula, but occasionally arising from a subperiosteal abscess, starting from a diseased tooth. These conditions have already been sufficiently described in the chapter on Diseases of the Jaws. *Epithelioma* is far from common. *Enchondroma, Fibroma, and various forms of Sarcoma*, have also been met with in this region.

SOFT PALATE.—The most common disease of the soft palate is syphilitic ulceration (Vol. I., p. 1147). Tumours are occasionally met with, and their nature has been specially studied by Stephen Paget, who has collected and analysed the records of a considerable number of such cases. *Congenital dermoid cysts* have been met with in this region. They are always situated in the middle line, and are supposed to be formed by inclusion of the epithelial layer during development. *Simple mucous cysts* are very rare. *Polypoid and warty growths* are not very uncommon. *Adenomata* form the largest class of tumours met with in this situation. They vary somewhat in structure, some closely resembling the adeno-fibroma of the breast, and others being composed of embryonic or myxomatous tissue surrounding groups of epithelial cells, sometimes forming distinct cell-nests. They are, however, always simple, and usually distinctly encapsuled, so that they can be readily shelled out after the mucous membrane covering them has been divided. They are of slow growth, and usually painless ; they are round or oval in form, smooth on the surface and firm in consistence. They are most commonly met with about middle life. In a case under the care of C. Heath in University College Hospital the tumour, which was shelled out without difficulty, measured one inch and a half in diameter. *Sarcomata* are rare, and are usually round or spindle-celled. *Squamous carcinoma* is also rare. It presents nothing peculiar.

UVULA.—**Elongation of the Uvula.**—The uvula occasionally becoming elongated and hanging down into the pharynx, so as to touch the epiglottis and sensitive mucous membrane in its neighbourhood, gives rise to great irritation of the fauces, or to a tickling or spasmodic cough, which can be cured only by removing the pendulous body. This little operation may be readily done after the application of cocaine by seizing the end of the uvula with a pair of polypus-forceps, and snipping it across near the root with a long pair of scissors. It is better not to remove the whole of the uvula. If this be done, throat irritation is apt to continue. I have been most satisfied with the result of those cases, in which a stump from a quarter to a third of an inch in length has been left. For some years I have been in the habit of using a pair of "vulsellum-scissors" (Fig. 753), by which the uvula is cut off at the same moment that it is seized, thus rendering the operation easier and less irritating to the patient. A very ingenious American instrument, consisting of a pair of forceps and scissors combined, may be employed with the same view ; by closing the handles of this instrument the uvula is first seized, and is then immediately cut across (Fig. 754). The throat is usually extremely painful for a few days after the operation, and swallowing is especially dreaded. The sucking of ice, and marsh mallow lozenges give marked relief.

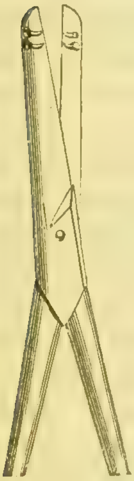


Fig. 753.—Vulsellum-Scissors.

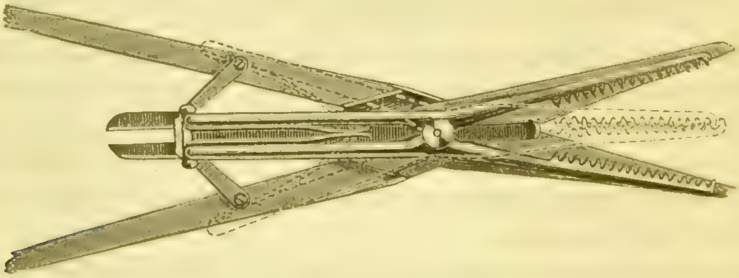


Fig. 754.—Forceps-Scissors.

TONSILS.—**Tonsillitis or Quinsy.**—The tonsils are not unfrequently inflamed or permanently enlarged. When inflamed, they become swollen and red, with much pain in the side of the neck and ear, increased by any attempt at swallowing ; there is usually a profuse secretion of saliva, and a good deal of swelling under the angles of the jaws ; the tongue is coated with thick pasty mucus, and the voice is thick and nasal. The disease comes on suddenly, often accompanied by high fever, chills, and occasionally even delirium. The thermometer frequently rises to 105°, or even higher. In some cases, a trace of albumen may be found in the urine. Tonsillitis is often caused by exposure to impure air, such as results from the escape of sewer-gas into a house, and it is not uncommon amongst the residents in hospitals. It occasionally precedes an attack of acute rheumatism, but the connection between the two diseases is not clear. It may be mistaken for diphtheria, scarlet fever, or erysipelas of the fauces. From diphtheria it is distinguished by the absence of exudation. The mucous secretion from the tonsil may somewhat resemble diphtheritic exudation, but it is distinguished by its want of adherence, as it is easily removed with a camel's-hair pencil. From scarlet fever, tonsillitis is distinguished by the absence of the red tongue, and by the redness of the throat being purple in tint, and limited to the tonsils and their immediate neighbourhood, and later on by the absence of rash. From erysipelas of the fauces it is more difficult to distinguish, but it will usually be found that the redness is darker in tint and less diffused than in erysipelas, and there is less œdematous swelling, and no tendency to the supervention of dyspnœa from œdema glottidis. There is also less glandular enlargement at the angle of the jaw.

The *Treatment* should always be commenced by a good purge ; a calomel and colocynth pill will be found most efficacious if it can be taken. Guaiacum in lozenges, or otherwise, is said sometimes to cut the disease short if administered at the very beginning. Hot fomentations must be continuously applied, and steam, either alone or with the addition of compound tincture of benzoin (ʒj in Oj), should be inhaled at intervals. The patient must be well supported by good beef tea and other liquid food. The difficulty in swallowing may be overcome by painting or spraying the throat with cocaine. Much relief may often be given by scarifying the tonsils with a probe-pointed bistoury ; and, if abscess form, it should be opened early with a sharp-pointed bistoury sheathed to within half an inch of its point by wrapping strapping round it. The inhalation of the steam from a pint of boiling water, to which has been added a teaspoonful of creasote or carbolic acid, will often give much comfort by allaying the fœtor of the breath.

Enlargement of the Tonsils.—There are two distinct forms of chronic enlargement of the tonsils. In one, these organs become increased in size in otherwise healthy children in consequence of *repeated attacks of inflammation*, and more especially of diphtheria, scarlet fever, and measles. In the second form, the enlargement is due to a *true hypertrophy* of the normal structures of the tonsil. The lymphatic follicles are enlarged and increased in number, and the connective tissue between them is more abundant and denser than natural. The crypts are deepened and are filled with an abundant mucous secretion, sometimes of cheesy consistence, and standing out from the mouth of the crypt so as to make the tonsil look as if covered with white dots. In rare cases, calcareous concretions may be found in the dilated crypts. This form of enlargement may be complicated by the effects of repeated attacks of inflammation.

When the tonsils are chronically enlarged, the condition is obvious on opening the mouth and depressing the tongue so as to expose the fauces fairly, and cannot be mistaken for any other morbid state.

In *chronic inflammatory enlargement* the tonsils are red, congested, and very liable, under the influence of slight causes, to violent attacks of acute inflammation with ulceration or abscess.

In *chronic hypertrophy* the tonsil presents different characters ; it is large, rather pale, hard, smooth, and semi-elastic. This disease is one which occurs in children and young persons who have a general tendency to strumous affections of the mucous membranes. Most commonly it develops without any assignable or external cause, usually commencing at five or six years of age, and gradually increasing up to puberty, a period when the functional activity of these glands is greatest, and when they are most exposed to irritation from zymotic diseases, especially scarlatina and measles. When once the tonsils have enlarged, they become a source of great inconvenience and of even serious derangement of health. The child is liable to attacks of inflammation of the throat, the tonsils then becoming congested, greatly swollen, and readily running into ulceration or suppuration. In consequence of these repeated attacks of inflammation, the enlargement of the tonsils increases, they become indurated, rugged-looking, and nodulated, projecting far forwards into the fauces, and sometimes even touching each other below the uvula. Respiration, articulation, and deglutition are now seriously interfered with. The mucous membranes of the nose and eyes are often chronically congested, and there is an increased secretion, from the back of the throat and nose, of thick, tenacious, unhealthy, or fetid mucus, the swallowing of which is deleterious. The child cannot sleep without snoring, and is apt to start up with a feeling of suffocation ; the voice becomes thick and husky ; the sense of hearing is blunted ; and, partly from the incipient deafness, partly from the difficulty of breathing causing the child to keep its mouth half open, the countenance assumes a peculiar vacant, semi-idiotic expression, which is very characteristic of the advanced stages of the disease. The most serious effect is the impediment to inspiration, which in the more chronic and severe cases will prevent the full inflation of the lungs, and thus occasion a permanent flattening and contraction of the chest, imperfect aëration of the blood, and an interference with general nutrition.

The *Treatment* of chronic enlargement of the tonsils will vary according to the age of the child, and the degree and kind of hypertrophy and induration of these organs. In the earlier and slighter forms of the disease, the enlargement of the tonsils may gradually subside as the child grows older and stronger ; and it is well not to be in too great a hurry to excise the tonsils in young children, but rather to adopt a course of constitutional treatment with the view of improving the general health, by means that are ordinarily had recourse to in the management of struma. The internal use of iron, and the local application of the tincture of iodine, or of burnt alum, are occasionally serviceable. The repeated introduction of a pointed stick of nitrate of silver into the cavities of the enlarged tonsil seems occasionally to be of use in arresting the enlargement. In the majority of instances, however, the disease will not be materially influenced by any therapeutic means that may be adopted ; and it becomes necessary to remove that portion of the growth which projects beyond the arches of the palate. This may be best done by the ordinary tonsil-guillotine. The throat should first be painted with a 20 per cent. solution of cocaine. The tonsil is then made prominent by pressing with the finger behind the angle of the jaw, and the ring of the instrument being passed over the tumour, the cutting blade is pushed forwards, and thus a slice of the projecting part of the growth is removed. In some cases difficulty is experienced in bringing the tonsil fairly into the ring of the instrument; this may be obviated by drawing it through with a vulsellum or double hook, and indeed, in some of the machines sold for the purpose a double hook is attached, which, being fixed into the tonsil, draws it forwards before it is sliced off (Figs. 755, 756, 757). In performing this operation it is best for the Surgeon to stand behind the patient, more particularly in excising the right tonsil, as he can thus look better into the mouth and have more command over the head; or he may stand in front, and use the left hand for the right tonsil, and *vice versâ* (Fig. 758). Should a guillotine not be at hand, the tonsil may be removed by seizing it with a vulsellum, drawing it forwards, and then taking off a slice with a probe-pointed bistoury, the base of the blade of which should be wrapped round with a piece of plaster, to prevent its wounding the tongue. In excising the tonsil in this way, care must be taken to cut from below upwards and inwards towards the mesial line, and on no account to turn the edge of the knife outwards, lest the internal carotid artery be endangered. The hæmorrhage that follows this operation is usually very trifling; but it may be sufficiently abundant to endanger the patient's life.

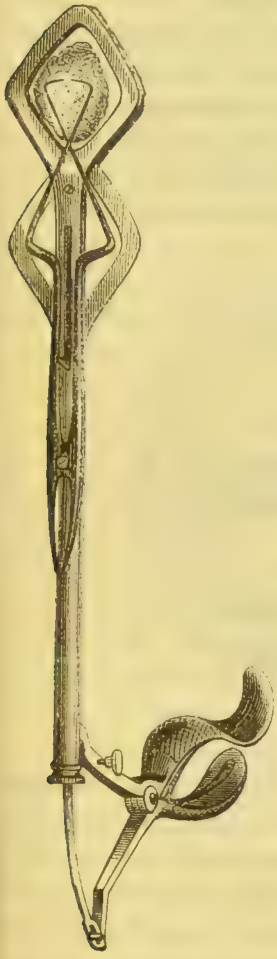


Fig. 755.—Tonsil-Guillotine applied.

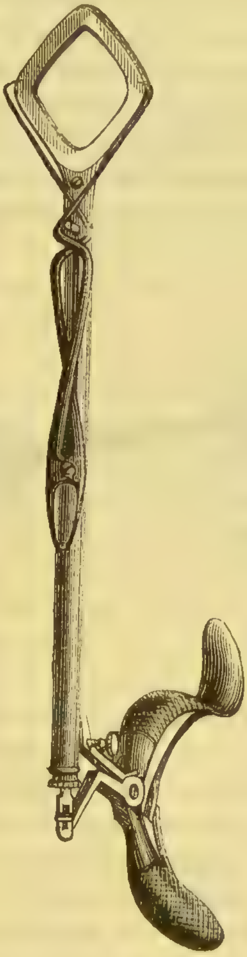


Fig. 756.—Tonsil-Guillotine shut.

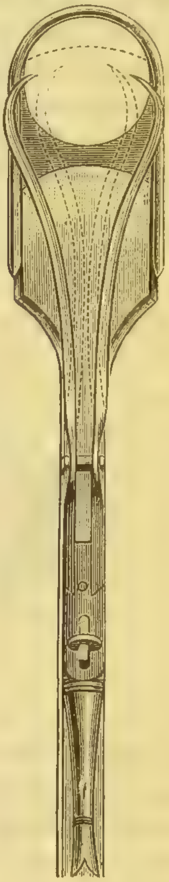


Fig. 757. — Tonsil-Guillotine, with Hooks to seize Tonsil.

In such cases, ice and gallic acid will usually arrest the bleeding. In one case, I found a gargle of spirits of turpentine suspended in mucilage effectual after all other means had failed.

It has been stated by some that excision of the tonsil is liable to be followed by arrest of development of the testes. This I have never observed.

Malignant Tumours of the Tonsil.—Squamous epithelioma, lympho-sarcoma, and round-celled sarcoma are the malignant growths most commonly met with in the tonsil and its immediate neighbourhood. **Epithelioma** rarely commences in the tonsil itself, but much more commonly extends to it from the root of the tongue or the pillars of the fauces. The tumour ulcerates early and deeply, and presents the hard base, foul surface, and everted edges observed in ulcerating epithelioma elsewhere. It early affects the glands. **Lymphadenoma, lympho-sarcoma, and round-celled sarcoma** spring more commonly from the tonsil or its immediate neighbourhood, and cannot be easily distinguished from one another except by microscopic examination after removal, and not always then. They have been met with most frequently after middle life. The lymphadenoma and lympho-sarcoma form soft, sometimes semi-fluctuating tumours rounded in form, often smoothly covered by tensely stretched mucous membrane, and projecting beyond the middle line of the pharynx, interfering more or less with deglutition and respiration. In most cases the growth is malignant, speedily implicating the lymphatic glands along the anterior border of the sterno-mastoid. These tumours may be loosely encapsuled, so that they can be shelled out easily with the finger after the mucous membrane covering them has been divided. Round-celled sarcoma infiltrates the neighbouring parts more widely, and shows the same general malignancy. If these growths are left without operation, swallowing becomes more and more difficult, respiration is impeded, ulceration and hæmorrhage may take place, and the patient dies in most cases from the effects of the local disease, but sometimes from secondary visceral growths.

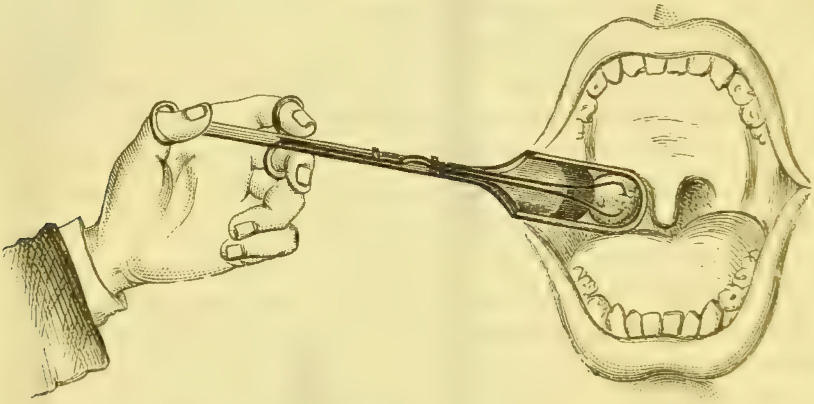


Fig. 758.—Removal of Right Tonsil with left hand.

If the disease is far advanced and widely infiltrating surrounding parts, nothing can be done by operative means for the relief of the patient. In one case of a malignant tumour of the tonsil, however, I obtained some temporary advantage by removing portions of the soft projecting and very vascular growth by means of the écraseur. When the tumour is stretching the mucous membrane over it without apparently implicating it, and when the whole mass seems movable in the side of the pharynx, it is probable that the tumour is a lymphadenoma or lympho-sarcoma, and it may then in many cases be easily removed from the mouth. The patient must be well gagged, the mucous membrane divided with a Paquelin's cautery-knife, and the mass enucleated with the finger. It is surprising with what ease and with how little hæmorrhage tumours of this kind, even when of considerable size, may be removed. Three cases, two under the care of A. E. Barker, have been removed in this way in University College Hospital. All recovered, were greatly relieved locally, but in all speedy recurrence took place in the glands of the neck. In one of Barker's, the glands were removed, and the patient was in good health a year afterwards.

If the tumour is too deeply attached to be shelled out in this way, it may be brought more fully into view by dividing the cheek as in the buccal operation for removal of the tongue, but this rarely gives enough room. It has therefore been attempted in several cases to expose the tonsil by incisions in the side of the neck. Cheever accomplished this by one incision along the anterior edge of the sterno-mastoid, and another joining it and passing along the lower border of the jaw. Foulis and Czerny recommended a more extensive incision, commencing at the angle of the mouth and passing downwards to the angle of the jaw and beyond it towards the tip of the great cornu of the hyoid bone. By sawing the jaw in this line and pulling the parts widely asunder the tonsil is brought very clearly into view. Mickulicz went a step further, and took away a portion of the ascending ramus of the jaw without opening the mouth. The details of these operations must necessarily vary with the seat of the tumour and the extent of the implication of the soft parts. The cutting in the deeper parts is best done with Paquelin's hot knife. The *results* have not so far been very satisfactory. Butlin, who has collected 23 cases of removal of malignant tumours of the tonsil, states that although only three died directly from the operation, recurrence had speedily taken place in the great majority of the survivors, only three being known to be alive and well at periods of four, twelve, and twenty-four months respectively after the operation. Local relief had, however, followed many of the operations, and doubtless, also, in most, life was prolonged. The operation is evidently justifiable in well selected cases, and should be done as soon as the nature of the disease is recognised.

DISEASES OF THE PHARYNX.

Pharyngitis.—*Acute catarrhal pharyngitis*, or the ordinary sore throat, is too familiar to every inhabitant of our damp and cold climate to need any description. Avoidance of cold, warm external applications and steaming the throat by means of an inhaler, usually soon effect a cure, which may be hastened at the end by an alum or port-wine gargle. *Chronic catarrhal pharyngitis* or "relaxed throat" is characterised by some redness and swelling of the mucous membrane, often accompanied by elongation of the uvula. The veins of the mucous membrane are often enlarged and visible, and the follicles slightly increased in size. There is an excess of secretion, usually thick and tenacious in character. It may follow repeated attacks of acute catarrh, but is much more commonly associated with dyspepsia caused by the excessive use of alcohol, tea, or tobacco. It is aggravated by cold and damp weather, and greatly relieved by warmth and dryness. The symptoms are usually worse in the morning, and consist in dryness and uneasy sensations as if from the presence of a foreign body, with a constant desire to clear the throat by coughing or to moisten it by drinking. The *treatment* consists first in avoiding the causes above mentioned. If there is any tendency to constipation saline purgatives may be given. Pepper, mustard, curry, &c., should be forbidden. Locally, astringent gargles, chloride of ammonium lozenges, and sprays of bicarbonate of sodium, chloride of ammonium or alum, or insufflations of pulv. catechu pallid. will be found most useful. Change of air to a warm dry climate will usually succeed when other means have failed.

Follicular or Granular Pharyngitis is an exaggeration of the preceding condition characterised by marked enlargement of the mucous follicles of the pharynx. The chronic catarrh usually extends into the post-nasal region and to the mucous membrane at the opening of the glottis. The causes are various, amongst the most common being abuse of alcohol and tobacco, but chronic dyspepsia from other causes may predispose to it. Excessive use of the voice is said also to be a cause. It is common in scrofulous subjects. The symptoms are those of ordinary catarrhal pharyngitis, increased in severity and accompanied by hoarseness or loss of voice, and frequently by some deafness from obstruction of the Eustachian tubes, and occasionally by loss of smell. On examination the enlarged follicles are seen forming rounded or oval eminences dotted over the mucous membrane, sometimes coalescing and forming larger elevations or ridges. Small tortuous dilated veins are very commonly present. Most commonly there is little or no excess of secretion, the throat being more or less dry and glazed, often with crusts of dried mucus upon it, especially visible on turning the velum upward. In another variety of the disease, described as the exudative form, there is a thick, opaque, tenacious secretion which hangs about the orifices of the follicles at the back of the pharynx. The *treatment* is often very unsatisfactory. The avoidance of all sources of irritation, of alcoholic excess, and of over-use of the voice is essential. The digestion must be attended to and the bowels kept regularly open. Locally the throat may be sprayed with astringent lotions, such as alum or tannic acid, or may be painted with glycerine of tannin, care being taken to pass the brush up behind the soft palate. When there is an accumulation of viscid mucus or dry crust in the pharynx, sprays through the anterior nares, and up behind the uvula, give great relief. The patient should learn to do this himself. If the throat is dry chloride of ammonium lozenges give much relief. The application of solid nitrate of silver to the enlarged follicles is sometimes of use, and in extreme cases they have been destroyed by the application of powerful chemical caustics or by the galvanic cautery, not merely rubbed over, but pushed into each separate follicle. Cocaine should be applied first, and a little (gr. ⅛ to ¼) of morphia in powder with starch blown over the place afterwards. If these severe measures are adopted only a few follicles must be treated at a time, otherwise dangerous inflammatory swelling may result.

Erysipelatous Pharyngitis is occasionally met with. It is characterised by an invasion and subsequent constitutional disturbance, like that of erysipelas (Vol. I., p. 944), with enlargement of the glands under the jaw. The mucous membrane is of a brilliant red colour, and considerably swollen. There is great pain in swallowing, and severe or fatal dyspnœa may follow from œdema of the glottis. The *prognosis* in these cases is always grave. The *treatment* consists in the external application of heat, the local application of a strong solution of perchloride of iron or nitrate of silver, and steaming the throat. The strength must be maintained by liquid food and stimulants. Should dyspnœa set in the larynx or trachea should be opened at once.

Diffuse Cellulitis of the Submucous Tissue of the Pharynx or Phlegmonous Pharyngitis is a very rare affection, arising occasionally from injury, but in other cases without evident cause. It commences with redness, swelling, and pain in swallowing, but the serious nature of the case is soon shown by the great elevation of temperature and severe constitutional disturbance. Œdema of the glottis sets in early. The disease is very fatal. After death the areolar tissue around the pharynx and larynx will be found soaked in pus and sometimes gangrenous. The *treatment* is very unsatisfactory. Scarification of the wall of the pharynx may be of use if there is great œdematous swelling, after which a solution of perchloride of iron (30 per cent.) may be painted on. Heat and moisture must be applied externally. Laryngotomy or tracheotomy may be required at any moment. As long as the patient can swallow, fluid nourishment and stimulants must be freely administered.

Abscess occasionally forms in the areolar tissue behind the pharynx, between the vertebral column and its posterior wall, which is consequently pushed forward so as to occlude the posterior nares, giving rise to a peculiar nasal intonation of voice, if the abscess be situated high ; if low down, the consequences are more serious, as it may interfere with respiration by pressing upon the upper part of the larynx. This kind of abscess is often connected with disease of the bones at the base of the skull, or of the upper cervical vertebræ. In many cases, if left to itself, it would burst through the mucous membrane into the mouth ; but in others it comes forwards under the sterno-mastoid muscles into the fore part of the neck. By exploring the pharynx with the finger, which may readily be done, tension and fluctuation through its posterior wall may easily be made out.

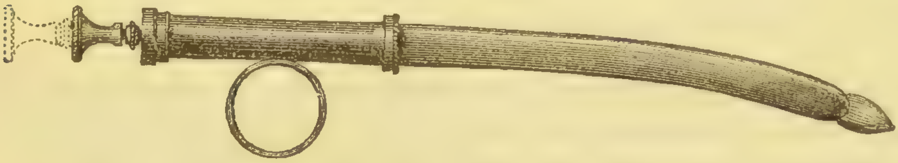


Fig. 759.—Pharyngotome.

In these cases the *Treatment* consists simply in letting out the matter by puncturing the tense membrane covering it. This may be done by means of a sharp pointed bistoury properly protected, the ordinary abscess-knife, or a pharyngotome (Fig. 759). The pus let out is often offensive. If there is reason to believe the abscess is connected with disease of the cervical spine an attempt should be made to open it externally, as described in the Chapter on Diseases of the Spine (p. 449).

Syphilitic Affections of the Pharynx have been already described (Vol. I., p. 1147). The consequences of extensive syphilitic ulceration may, however, be alluded to here, as they occasionally call for surgical interference. As the ulcers heal the pharynx may contract so that deglutition becomes difficult, fluids only being able to pass. In such cases some relief may occasionally be given by careful division of some of the tight cicatricial bands which narrow the fauces, followed by the passage of bougies. Sometimes the soft palate becomes adherent to the posterior wall of the pharynx, completely shutting off the nasal cavity. For this condition nothing can be done, as it is impossible to set the soft palate free, and an opening through it would only add to the patient's discomfort.

Tumours are occasionally met with in the postpharyngeal areolar tissue, giving rise to the same swelling, difficulty in respiration and deglutition, and lateral projection, as occur in abscess of this region. These growths are mostly malignant, and speedily prove fatal. *Polypi* in the pharynx usually come down from the nasal cavities, but sometimes spring from the inside of this canal on one or other of its margins. They are usually, when truly pharyngeal, of a malignant character, and grow with great rapidity. The uses of the part are necessarily interfered with, and death may eventually result from obstruction to deglutition and respiration. The so-called *fibrous polypus* projecting from the base of the skull into the pharynx has been already described, p. 576. *Epithelioma* of the pharynx has occasionally been met with (Fig. 760). This form of the disease, which is of rare occurrence, does not differ from similar growths elsewhere.

DISEASES OF THE ŒSOPHAGUS.

In discussing the diseases of the œsophagus it will be most convenient to consider first the diseases that may affect that canal, most of which cause narrowing of its lumen and consequent dysphagia, and subsequently to describe the symptoms and treatment of stricture of the œsophagus in general.

Congenital Malformations are very rare, the most common being a communication between the œsophagus and trachea which is incompatible with life. Congenital fistulæ and diverticula have also been met with, and three cases have been recorded of difficulty in swallowing existing from an early age to adult life, and proved after death to have been due to narrowing of the upper end of the œsophagus.

Inflammatory Affections of the Œsophagus are not common, except as the result of injury or the swallowing of corrosive fluids. Chronic catarrh is said to occur in spirit-drinkers, with enlargement of the mucous glands. Superficial ulceration may take place in them, and has been known to give rise to somewhat profuse hæmorrhage. Chronic catarrh is usually accompanied by some muscular hypertrophy. The symptoms of this condition are too indefinite to allow of accurate diagnosis, and the pathological appearances have been observed in patients dying from other causes. It is possible, however, that long-continued catarrh may be a cause of simple stricture.

Ulceration of the Œsophagus may be simple, syphilitic, tubercular, or malignant, all of which are rare except the last. Simple ulceration is most commonly traumatic, arising from the impaction of a foreign body or from swallowing a corrosive fluid. It may in rare cases arise as a consequence of chronic catarrh. Chronic ulceration of the same nature as that occurring in the stomach is said to occur in the œsophagus at the cardiac end, but it is somewhat doubtful. The œsophagus may, however, be implicated in a gastric ulcer, and the cardiac orifice thus narrowed. Syphilitic and tubercular ulceration are both decidedly uncommon, though several such cases have been recorded. Perforation of the œsophagus, as the result of ulceration, very seldom occurs except in malignant disease. All forms of ulceration tend to cause narrowing of the canal. In the malignant form this is the result of the cancerous growth surrounding the tube ; in the other varieties it is due to cicatricial contraction as healing takes place. The symptoms of ulceration of the œsophagus are pain and difficulty in swallowing, usually referred to some definite spot. The patient may occasionally bring up blood. The diagnosis of one form of ulceration from another must always be uncertain. But little can be done in the way of treatment beyond supporting the patient's strength by the administration of bland fluid nourishment. If there is any reason to suspect ulceration great caution should be exercised in passing a bougie, lest the diseased coats be perforated. If the ulceration be not malignant the signs of stricture of the œsophagus manifest themselves as the sore heals.

Diverticula from the Œsophagus are occasionally met with. According to Zenker and Von Ziemssen they are of two kinds, one being due to pressure from within, and the other to traction from without. The former are not common : they are formed by a protrusion of the mucous membrane through the muscular coat, usually rather in the lower end of the pharynx than in the œsophagus. The pouch thus formed has varied in the recorded cases from the size of a hazel-nut to that of a child's head. It is always situated behind, lying between the vertebræ and the œsophagus, and extending downwards along the spine, in some cases reaching even to the bifurcation of the trachea. The development of the sac is very slow, some of the recorded cases having lasted for ten or even twenty years before giving rise to serious symptoms. The symptoms produced by these diverticula are due to the distension of the sac with food, by which the œsophagus is pressed upon and deglutition interfered with to such an extent as even to cause death. When the sac is distended with food it forms a swelling on each side of the neck, in which a gurgling may be felt on manipulation. By firm pressure the food, sometimes in a more or less advanced state of putrefaction, may be forced back into the pharynx. In some cases the patients have learned to do this for themselves, and by repeatedly emptying the sac and attempting to swallow again, have managed to get down sufficient food to maintain life. A bougie passed down the throat commonly enters the pouch, and can be moved about in it ; great care must, however, be used if a diverticulum is suspected, lest the instrument be forced through its wall. The *causes* of these diverticula are very uncertain. They have been most commonly met with after the age of 30. They are not connected with narrowing of the gullet below. It is probable that they are due to some congenital weakness or malformation of the part. But little can be done in the way of *treatment.* Owing to the difficulty of avoiding the entrance to the pouch, it is almost impossible to feed the patient by means of a tube. If, therefore, starvation is imminent, gastrostomy gives the best chance of life. It has been suggested by König to remove the sac and close the opening, but this operation has not yet been attempted.

The funnel-shaped diverticula due to traction from without are smaller. They are commonly seated near the bifurcation of the trachea, in the anterior wall. They are caused by the contraction following inflammatory processes outside the œsophagus, such as the inflammation of a bronchial gland. They are of little consequence, and give rise to no serious symptoms, unless a foreign body should happen to lodge in the pouch, and there set up inflammation and ulceration. Their presence has only been recognized after death.

Simple Tumours of the Œsophagus are rare and usually assume a polypoid form. Fibromata or Myofibromata have been most frequently met with, but Klebs states that lipoma and myxoma have also been observed.

Cancer of the Œsophagus is by no means uncommon. It occurs chiefly in three situations, at the upper end of the gullet, implicating also the lower part of the pharynx behind the larynx, about the middle opposite the bifurcation of the trachea, and at the cardiac end ; but it has been met with in all parts of the canal. In at least 70 per cent. of the cases the disease assumes the form of squamous carcinoma (epithelioma), and this is almost invariably the case when it is seated at the upper part. At the lower end glandular carcinoma is more common. A few rare cases of glandular carcinoma (scirrhous or more rarely encephaloid), apparently originating from the mucous glands, have been met with in other parts of the canal. All forms of carcinoma tend to spread round the tube, and thus diminish and finally occlude its lumen, giving rise to the symptoms of stricture of the œsophagus. Ulceration occurs sooner or later, and may lead to perforation into the pleural cavity or the trachea according to the situation of the growth, or a large vessel may be opened, causing hæmorrhage. In the great majority of cases, however, death occurs from starvation before the local disease is sufficiently advanced to cause these complications. Secondary growths are rare except in the lymphatic glands. In a case lately in University College Hospital, however, secondary growths occurred in several bones as well as in the lymphatic glands and lung. Spontaneous fracture occurred in the humerus on each side, and in one clavicle. Microscopic examination showed the primary tumour, which was seated a little below the larynx, to be a glandular carcinoma. The further symptoms and treatment will be discussed with stricture of the œsophagus.

Stricture of the Œsophagus and Dysphagia.—The characteristic feature of all forms of œsophageal obstruction is that the patient is conscious of the fact that the bolus of food after leaving the pharynx is arrested at some point on its way to the stomach. He will usually indicate the point with his finger externally, and often with great accuracy. Dysphagia may be due to three classes of causes ; first, to conditions unconnected with any actual narrowing of the œsophagus ; secondly, to nervous or spasmodic stricture ; and thirdly, to organic stricture.

Conditions producing Dysphagia independently of Stricture.—These are numerous, and may be divided as follows :—

1. **Tumours connected with the Pharynx.**—Putting out of consideration tumours of the tonsils, which would always be readily discovered, *polypus* of the pharynx may hang down and offer obstruction to the passage of food. In all polypoid growths connected with the pharynx (which are exceedingly rare) the nature, connections, &c., of the growth may be made out by drawing the tongue well forward, keeping it fixed with the tongue-spatula, and passing the finger well down behind the root of the organ ; the pharynx can thus be explored, even below the root of the epiglottis, without much difficulty. *Abscess* may exist between the posterior wall of the pharynx and the spine, possibly arising from caries of the cervical vertebræ ; or a *postpharyngeal tumour*, as, for instance, a sarcomatous growth, may be developed from the

bodies of the vertebræ, and push the pharynx forwards. The eye is often deceived in these cases, failing to detect the existence of an enlargement at the back of the pharynx ; but the finger readily recognizes it. In the case of abscess there is fluctuation, and the dysphagia will be removed by opening the abscess and letting out the contents ; and the solid, or semi-solid and soft, or other feel of a tumour in this situation will lead to a very probable guess as to its nature. Diverticula from the upper end of the œsophagus or lower end of the pharynx (p. 691), are also a rare cause of dysphagia. Angular curvature forwards of the cervical spine projecting into the pharynx has been recorded as causing dysphagia.

2. **Morbid Conditions of the Larynx.**—Œdema about the back of the epiglottis, or ulceration, and thickening of the mucous membrane there, dependent upon syphilis or tubercle or œdema about the rima glottidis, may give rise to a tendency for liquids to pass into the air-passages, and thus occasion a serious impediment in swallowing, the difficulty being attended with a feeling of spasm and suffocation. By passing the finger down behind the root of the tongue, the state of parts can sometimes be felt, and the actual condition can be readily ascertained by the use of the laryngoscope ; but the combination of dysphagia with a suffocative fit, and these probably associated with laryngeal cough, are the chief points in the diagnosis.

3. **Tumours in the Neck outside the Œsophagus.**—Enlarged glands or a carotid aneurism, developing posteriorly, as has been known to occur with the internal carotid artery ; or a tumour connected with the thyroid body, tightly bound down by the sterno-mastoid muscles and cervical fascia, may, by pressing on the œsophagus, give rise to dysphagia. In all cases where that symptom is complained of, the neck should be examined carefully for tumours, which will generally be very readily detected, especially where the difficulty has existed for some time, and the person has become much emaciated from deficient nourishment.

4. **Aneurism of the Innominate Artery.**—When this disease has risen into the root of the neck it is easily recognizable ; but in certain cases it develops first in a direction backwards, and then one of the earlier symptoms is dysphagia. Indeed, the patient may suffer but little from any other symptom, and may apply to the Surgeon for relief from it alone, quite unconscious of the existence of any serious disease. The diagnosis will be effected by careful attention to the symptoms described at pp. 162 *et seq.*, Vol. II. In such a case, much danger might be incurred by at once putting an instrument into the œsophagus, under the impression that stricture existed ; for the point of the bougie, or whatever instrument might be used, might perforate the sac of the aneurism, and so give rise to instant death.

5. **Aneurism of the Aorta,** whether of the fusiform or the sacculated variety, may give rise to difficulty of deglutition by pressure on the gullet. In this case, also, there is great danger of the aneurismal sac being pierced by an instrument passed down for the purpose of ascertaining the existence of stricture. The presence of the symptoms of intrathoracic aneurism, described at pp. 154 *et seq.*, Vol. II., will determine the diagnosis.

6. **Intrathoracic Tumours,** such as enlarged bronchial glands, sarcomatous and other growths, developed from the thoracic spine into the posterior mediastinum, may compress the œsophagus. In such cases the diagnosis is very difficult. It is difficult enough to determine the existence of a tumour,

but still more so to distinguish it from an aneurism undergoing consolidation: but dulness on percussion, and dyspnœa with dysphagia, together with fixed pain in or to one side of the spine, with neuralgia down the arms or up the side of the head, and a varicose condition of the superficial veins of the chest, are the signs on which we place our chief reliance in diagnosing the existence of a tumour.

7. **Dislocation of the Sternal End of the Clavicle Backwards,** whether traumatic, or produced in consequence of excessive lateral curvature of the spine, may give rise to difficulty of deglutition. Of the latter kind there is one case on record, narrated by Sir Astley Cooper, in which the sternal end of the clavicle by its pressure so obstructed the passage of food, that the patient was brought into a condition of extreme danger. Davie, of Bungay, under whose care the woman was, sawed through and detached the sternal end of the clavicle, and thus completely relieved her.

8. **Impaction of a Foreign Body in the Gullet.**—If a man swallow such a thing as a piece of mutton-bone, or the settings of artificial teeth, it generally lies across the gullet in such a manner as to be easily felt by the Surgeon on passing a probang; but there are others cases in which a foreign body becomes so lodged in the canal as to escape detection and removal. Some years ago I was requested to see a patient who was said to have swallowed a piece of gutta-percha. He had, it appeared, in consequence of having lost several teeth, endeavoured to construct an artificial masticatory apparatus for himself, which had become loose, and he had accidentally swallowed it. A few days afterwards, finding that deglutition continued difficult, he consulted a very able Surgeon, who carefully examined him; but, not detecting any foreign body, he considered that the piece of gutta-percha had passed into the stomach, and that the œsophagus had been scraped by it in its passage down. Inability to swallow solids came on. I saw him six months afterwards. The question then was, whether the foreign body was still impacted in the œsophagus, or whether the symptoms arose from damage inflicted on that tube. I examined the œsophagus most carefully, but failed, as other Surgeons had previously done, to discover the existence of any foreign body. I thought that the œsophagus had been injured in some way, and that probably epithelioma was developing, and would, sooner or later, prove fatal. One day, while at dinner, the patient suddenly vomited a large quantity of blood, and fell down dead. On examination after death, we found that the piece of gutta-percha had formed for itself a bed in the wall of the œsophagus, lying parallel with the inside of the tube, and that the ulceration of the mucous membrane caused by its presence had opened some vessel—which, we could not ascertain (it was not, however, either the carotid artery or the jugular vein)—thus giving rise to the copious and sudden hæmorrhage which had caused the patient's death. The surface of the gutta-percha which looked into the œsophagus, being constantly covered over by mucus, and being protected, as it were, by a rim of swollen mucous membrane all around it, had allowed the probang to pass easily without its presence being detected.

9. **Paralysis of the Muscles of Deglutition** occurs occasionally as a sequence of diphtheria, and in the rare affection of the medulla known as labio-glosso-pharyngeal paralysis, but this is hardly to be confounded with obstruction of the œsophagus.

In the **Diagnosis** of stricture of the œsophagus it is necessary to bear these conditions in mind, and if possible to exclude them before proceeding to examination of the gullet by means of a bougie.

Hysterical or Spasmodic Stricture is met with chiefly in females under twenty-five, though it may occur in older persons of the hysterical temperament. It is possible for it to occur without evident organic disease or change of any kind. But I believe that the simple and pure uncomplicated hysterical stricture is of very rare occurrence. In the majority of instances it will undoubtedly be found to be dependent upon some local change of structure, most commonly of a simple kind, such as chronic inflammation of the pharyngeal mucous membrane, ulcerative abrasion of it, or follicular inflammation about the epiglottis and posterior part of the larynx. The disease in many cases is supposed to be dependent on or to have been occasioned by the swallowing of some foreign body, as a fish-bone, bead, bristle, &c., which after many months is still thought to be impacted. This is almost always erroneous. The foreign body may have been swallowed, and may have been the starting-point of the slight inflammation or ulceration that occasions the dysphagia, but it has long since disappeared, leaving merely a series of troublesome consequences in its train. The obstruction is generally high up in the pharynx, rather than in the œsophagus; being produced by the contraction of the constrictor muscles. The dysphagia is intermittent; when the patient's mind is allowed to dwell long on the affection, and she becomes anxious about it, then the difficulty is greatly increased; whilst at other times, when her thoughts are diverted from it, food passes easily. It will be found also, in these cases, that on attempting to pass a probang or large bougie, its progress will at first be resisted, but, by patiently and gently pressing upon the stricture, the instrument will soon pass easily.

Organic Stricture, as before stated, may be fibrous or cancerous. *Fibrous Stricture* is in the great majority of cases due to the contraction of a scar resulting from injury or from the swallowing of corrosive fluids. It is said in very rare cases to be a consequence of chronic catarrh, of syphilitic or of tubercular ulceration. At the cardiac orifice it may be due to the contraction caused by the healing of a chronic ulcer of the stomach. *Cancerous Stricture* is more common than fibrous. The nature of the growth has been already described (p. 692).

Organic stricture, whether fibrous or cancerous, is characterised by a progressively increasing difficulty in swallowing, often quite unaccompanied by pain. At first the difficulty only occurs with somewhat large solid masses, then the patient can only swallow soft or finely divided substances, then fluids pass with difficulty, and finally complete obstruction sets in, and unless relieved in some way the patient dies of starvation. If the obstruction is some way down the œsophagus commonly becomes dilated above it, and a pouch is thus formed, which may contain some ounces of fluid. Small quantities are thus apparently swallowed, but after a short time are returned. Sometimes the returned fluid is brought up suddenly with some force, as if squirted up rather than vomited. It may thus come out partly through the nose. The matter brought up shows evidence of not coming from the stomach, being still alkaline if so when swallowed. By auscultation along the back while the patient swallows a mouthful of water, it is sometimes possible to ascertain the point at which the downward passage of the fluid is arrested. A harsh cough, with hoarseness or aphonia, is sometimes met with, probably from irritation of the recurrent laryngeal. The patient may suffer much from accumulation of mucus about the glottis, which he can neither bring up nor swallow. Occasionally much discomfort may be caused by flatus rising from the stomach into the œsophagus below the stricture.

In the **Diagnosis of Organic Stricture** it is necessary to determine first the presence of the stricture, and secondly, if possibly, whether it be fibrous or cancerous. The other causes of dysphagia having been excluded if possible, the presence of the organic stricture may be determined by examining the canal with a bougie.

To pass an œsophagus-bougie the Surgeon should stand before the patient, who should be seated. The bougie should be softened in warm water and greased with glycerine, which is pleasanter to the patient than oil. The head must be inclined slightly forwards ; if it is thrown back the larynx is pressed against the spine, and the bougie will not pass readily. The obstruction thus caused is easily mistaken for a stricture. The instrument before being passed may be slightly curved, and it must be guided down the pharynx by the forefinger passed into the mouth. It commonly causes retching and some dyspnœa as it passes the glottis. There is no fear of passing the bougie even when small into the larynx by mistake, as the point of the instrument is directed towards the posterior wall of the pharynx. After the point of the instrument has passed the glottis, the patient will breathe more easily, and it may then be steadily passed onwards. If an obstruction is met with the bougie may be gently and steadily pressed against it, but if it does not readily yield a smaller instrument must be tried and so on until one passes if that be possible.

The facts ascertained by the use of the bougie are the seat and degree of the stricture. It may also furnish some evidence as to the nature of the disease. If it gives the sensation of passing over a rough irregular surface, and if when no force has been used blood is found on the bougie or is brought up afterwards, it would suggest the existence of a malignant growth, but the absence of these signs by no means proves that the stricture is fibrous.

The diagnosis may, however, be made by attention to the following points. In *simple stricture* there is probably a history of the cause, such as injury, swallowing caustic fluids, or possibly of syphilitic ulceration in the pharynx. Any stricture in a patient below 30 is probably not cancerous. Slow development of the obstruction is in favour of a fibrous stricture. In *cancerous stricture* the disease occurs after 30, and in men more often than in women. It develops rapidly, the history seldom extending beyond six months when the case is first seen. Blood and pus may be brought up with the vomited matter. The mass formed by the tumour may sometimes be felt in the neck, and enlargement of the lymphatic glands is commonly present. The diagnosis will, however, often be uncertain, especially when it is remembered that epithelioma may commence in a scar in the œsophagus as in other parts of the body. No *œsophagoscope* of practical utility has as yet been designed, though various attempts have been made to devise such an instrument.

Treatment.—The treatment of a stricture of the œsophagus will depend upon its nature. In the *hysterical variety*, the occasional introduction of a full-sized œsophagus-bougie, the application of belladonna to the neck, and anti-hysterical treatment generally, iron, aloëtics, assafœtida in large doses, douches, and diverting the patient's mind, are the means to be employed.

In the treatment of *organic stricture* care must be taken to maintain the patient's strength by proper feeding. Finely minced meat, strong soups, raw eggs, and soft puddings should be given so long as the patient can swallow them. As the difficulty becomes greater so that even liquids can only be taken slowly and in small quantities, it becomes necessary to feed the patient through a gum elastic tube passed beyond the stricture.

When feeding by a tube becomes necessary, it has been recommended to tie it permanently in position. This, however, prevents the swallowing of the saliva and causes considerable irritation where it lies against the larynx. To obviate this, Charters Symonds successfully used a gum elastic tube, about six inches in length and the size of a No. 10 or 12 catheter, the upper end of which was funnel-shaped, so as to rest upon the stricture. To the edges of the funnel two silk threads were attached and brought out at the mouth by which the tube could easily be removed when necessary. It was passed by means of a common bougie inserted into the funnel. In Symonds's case the man wore the tube for eight months after natural deglutition had become impossible, swallowing easily through it. It was changed about once in two weeks unless it became choked. Although the stricture was malignant the presence of the tube did not seem to aggravate the disease.

When feeding by a tube is impossible, the patient may still be kept alive for some weeks by nutritive enemata, but inevitably dies before long of starvation unless relieved by operation.

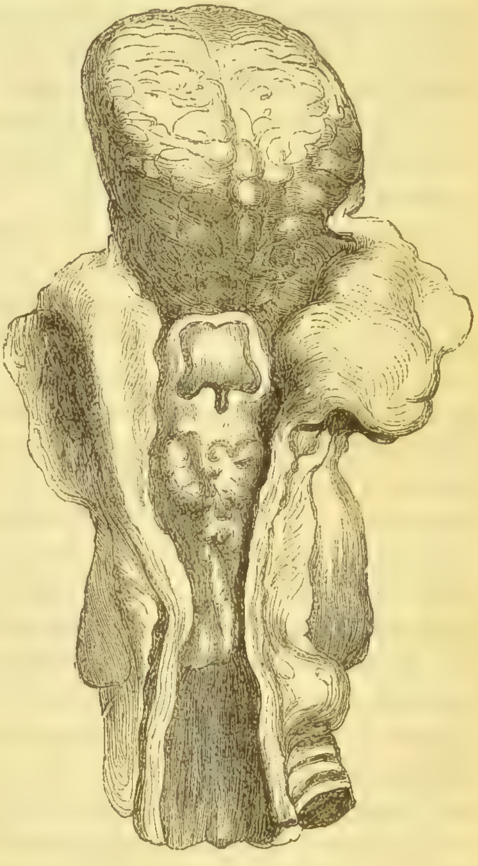


Fig. 760.—Epithelioma of Pharynx and Œsophagus causing Stricture.

In the treatment of the stricture much will depend upon its degree and nature. In simple cicatricial strictures, if not very extensive or very narrow, much may be done by the repeated passage of conical bougies, which the patient may be taught to use for himself. In this way he may succeed in keeping the canal patent; but should he neglect the treatment a relapse speedily follows. In introducing bougies into the stricture there is often a good deal of difficulty, more particularly when the constriction commences suddenly and the œsophagus is dilated above it. This may, however, be overcome in most cases by patience and care. Besides the simple dilatation by bougies, various other modes of treatment analogous to those adopted in stricture of the urethra have been tried with more or less success. I have in some cases seen temporary benefit result from the use of a catheter, surrounded by a tube of vulcanized india-rubber, which admitted of dilatation by the injection of water or air when introduced through the stricture; or from the employment of a tubular instrument, by passing a long small-sized bougie through the constriction, and then slipping a gum-elastic catheter with a rounded terminal aperture over it. It is needless to observe that, in the treatment of stricture of the œsophagus with bougies, no force should be used, lest the walls of the canal be perforated.

Various instruments have also been invented for mechanical dilatation by separation of metal blades by a screw action, but the results attending their use have not been as a rule satisfactory. Internal division of the stricture by a concealed knife passed through it has also been attempted. Gross has collected 18 cases in which this operation was performed. Of these 2 died of peritonitis, 2 from the effects of complete division of the œsophagus, 1 from hæmorrhage, and 1 from pleurisy ; and of the survivors only 3 seemed to be really benefited. In three cases of simple stricture at the cardiac orifice Loreta dilated the lower end from an opening made in the stomach, which was closed at once ; all recovered. If other means fail, as they most commonly do, the operations of œsophagostomy or gastrostomy must be performed as in malignant stricture, and with a fair hope of restoring the patient to tolerable health, especially in cases of cicatricial strictures after swallowing caustics in children.

In *malignant stricture* it is evident that the passage of bougies can be of little service, and possibly may do harm by hastening ulceration, or even be fatal by perforating the diseased œsophagus. When therefore natural deglutition becomes impossible and a fine tube can no longer be passed, death can be delayed by nutritive enemata. By these means I have known life prolonged, by a frail tenure it is true, for many weeks. In such cases it is an interesting physiological fact that, although the patients may continue to be moderately well nourished, and do not feel the pangs of hunger, they suffer excessively from thirst. Under these circumstances it was proposed by Sédillot to make a fistulous opening into the stomach, and thus directly to introduce food into that organ. To this operation he gave the name of *Gastrostomy.*

Operation of Gastrostomy.—The object of the operation is to expose the stomach, and to make a fistulous opening in that part of it which is naturally in contact with the abdominal wall, and uncovered by the ribs. The operation consists of three stages :—1. The exposure of the stomach ; 2. Its adhesion to the lips of the incision in the abdominal wall ; 3. The making of an opening into it. The area to be exposed is not large, and corresponds externally to the cartilages of the eighth, ninth, and tenth ribs ; above and internally it is bounded by the lower edge of the liver. In the contracted state of the stomach the pylorus lies immediately to the right of the middle line ; it is advisable, therefore, to make the incision as far to the left as can conveniently be done. Sédillot divided the abdominal wall by a crucial incision, each limb of which was about an inch and a half in length. Further experience has shown that so large a wound is not necessary. Labbé recommends an incision about an inch and a quarter to an inch and a half in length, parallel to the left costal cartilages, and one inch from their borders, terminating below at an imaginary line drawn between the most prominent points of the convexities of the two ninth cartilages. This incision will be found to divide a few fibres of the external oblique and notch the edge of the rectus ; beneath this is the expansion from the internal oblique and the upper fibres of the transversalis, under which lie the transversalis fascia and the peritoneum. Howse, who has had great experience in this operation, recommends a somewhat longer incision in the same direction, commencing about one inch and a half from the middle line. When the sheath of the rectus is exposed he holds the wound widely open, and makes a vertical incision in it a little way from its outer margin. The fibres of the muscle are then separated with the handle of the scalpel, and the posterior layer of the sheath and peritoneum also divided vertically. The fibres of the rectus thus exert a sphincter-like action on the opening when the wound is healed. In whichever way the abdominal wall is divided, all bleeding must be carefully arrested before the peritoneal cavity is opened. On dividing the peritoneum the stomach may present at the wound, and may be grasped with the fingers and drawn out. If it is not at once seen the finger must be introduced and the lower border of the liver felt for, immediately below which will be the stomach. When the stomach is felt, it may be drawn up into the wound by the fingers, if possible, if not, by a pair of ring-forceps; vulsellum-forceps must on no account be used. If the omentum presents in the wound, it should be drawn gently downwards until the stomach comes into view. The only viscus which can be mistaken for the stomach is the transverse colon, the left end of which immediately before the splenic curvature may present in the wound. The stomach can be recognized by the thickness of its walls and the extent and smoothness of its surface. The next step is to secure it to the opening. This is best done by carbolized silk sutures passed through the serous and muscular coats only. This is easily accomplished by gently pinching the coats of the stomach between the finger and thumb, when the mucous coat will be felt to slip away, leaving the other two in the grasp of the fingers. The stitches must be passed first through a good thick piece of the stomach, then through the peritoneum, which should be drawn a little forward by forceps, and then through the skin and fat, missing the muscular tissue of the abdominal wall. In this way the serous surfaces will be brought very accurately in contact. All the stitches must be passed before any are tightened; they must be not more than one-sixth of an inch apart, and must be so arranged as to enclose a circular area of the stomach wall about the size of a shilling. Finally the stitches are tightened and the wound dressed, with proper attention to the prevention of decomposition. Howse recommends the insertion of a double row of sutures in the following way. Drawing the stomach well over to one side, a needle, in a handle, threaded with silk should be passed through the serous and muscular coats, and made to transfix the abdominal wall about one inch from the wound. The needle is then withdrawn, leaving one end of the silk on the surface, and without withdrawing the other end the abdominal parietes are again punctured. The silk is now unthreaded and the needle withdrawn. Six or eight sutures are introduced in this way, and then tied over a bit of bougie or a folded piece of carbolic gauze. In this way firm adhesions are secured for some distance round the opening. The second row are then introduced in the way above described. After the operation a small quantity of beef-tea may be introduced into the stomach with the finest aspirator-needle if the patient is very exhausted, and this may be repeated daily, but if the strength is fairly good he should be nourished for the next four or, if possible, five days by nutritive enemata. By that time the stomach will have formed firm adhesions, and may be safely opened. This is done by passing a narrow scalpel through the adherent portion of the stomach, and making an opening large enough to admit a No. 10 catheter, into which an india-rubber tube fitted with a shield, or a small tracheotomy tube, may be passed; the orifice of the tube may be closed with a cork. At first only milk or pancreatized food should be introduced, but, as the stomach becomes stronger, minced meat, bread, and other food may be used.

The chief danger of the operation is peritonitis, but the risk of this has been very greatly diminished, first by the adoption of the method of operating in two stages, and secondly by the use of antiseptics. The advantage of delaying the opening till firm adhesions have formed is clearly shown by the statistics published by C. L. Vitringa, who has collected altogether the records of 155 cases of gastrostomy. From these he shows that before the introduction of antiseptic treatment 55 per cent. of the patients operated on died directly from the operation, but since that period the death-rate has been reduced to 27 per cent. If the antiseptic cases are divided into those in which the opening was made into the stomach at the time of the operation and those in which it was delayed till adhesions had formed, we find the death-rate was 53 per cent. in the former and only 17·5 per cent. in the latter. In many cases, although the patient does not die directly from the operation, life is but little prolonged by it, as the stomach seems unable to resume its functions. This most commonly has happened in cases of malignant stricture, in which the operation has been deferred till the patient is in the last stage of exhaustion. This is clearly shown by the statistics collected by Gross of 167 cases in which the operation was performed for malignant stricture. Of these 117 died within the first month, 49 directly from the operation, 28 more died under ten months, and only 1 survived a year. In such cases the advantages and the dangers of the operation must be laid fairly before the patient, but it is not the duty of the Surgeon to urge him to submit to it.

In cicatricial strictures, on the other hand, when death from starvation is otherwise inevitable, the Surgeon is justified in advising the operation. Gross has collected 37 cases of this kind. Of these 20 died within a month, 11 directly from the operation. Of the remaining 17, 9 survived to the fourth year, in 1 the record was incomplete, and 7 were living at the time of the report. In a case of this kind operated on by Trendelenburg, the patient was alive and well many years after the operation. He took food by masticating it thoroughly and then blowing it from his mouth into the stomach through a tube fitted to the cannula.

In many cases a good deal of trouble has been occasioned after the operation by the escape of gastric juice from the fistula. This causes great irritation of the surrounding skin apparently by a process of digestion. It is best avoided by not making a larger opening than is absolutely necessary. In the vertical incision adopted by Howse the sphincter-like action of the fibres of the rectus tends in great measure to prevent this complication. Should the skin become sore it may be relieved by being washed with an alkaline solution and protected by vaseline.

In a few cases **œsophagostomy**, or making a fistulous opening in the gullet below the obstruction, has been practised instead of gastrostomy. The operation is performed in the same way as for removal of a foreign body (Vol. I., p. 853), a tube being inserted through which food can be administered. Gross has collected 21 cases of malignant stricture treated in this way. Only four recovered from the operation, and all these died under six months. Of five cases of simple stricture treated by this method none recovered. It is evident, therefore, that this operation is not preferable to gastrostomy.

Œsophagectomy, or excision of the cancerous portion of the œsophagus, can only be practised in the early stages of the growth, before it has formed any adhesions to important parts, and only when the disease is seated at the upper extremity of the œsophagus. It was suggested by Billroth, and first successfully performed by Czerny in 1877. Since then the operation has been performed in five other cases. Of the six, three died directly from the operation, and of the survivors all died within a year of recurrence.

In the later stages of malignant stricture of the upper part of the œsophagus, *tracheotomy* occasionally becomes necessary, from implication of the glottis or larynx.

DISEASES OF THE LARYNX.

The larynx may be the seat of a great variety of morbid conditions. Acute, œdematous, and follicular inflammation; ulcerations and chronic thickenings of the mucous membrane; inflammation and necrosis of its cartilages; and the formation of tumours or polypoid growths in its interior, may all occur.

Laryngoscope.—It is of the utmost importance in the diagnosis, and for the proper treatment of these affections, that a view should be obtained of the parts that are the seat of disease. This can be done only by means of the

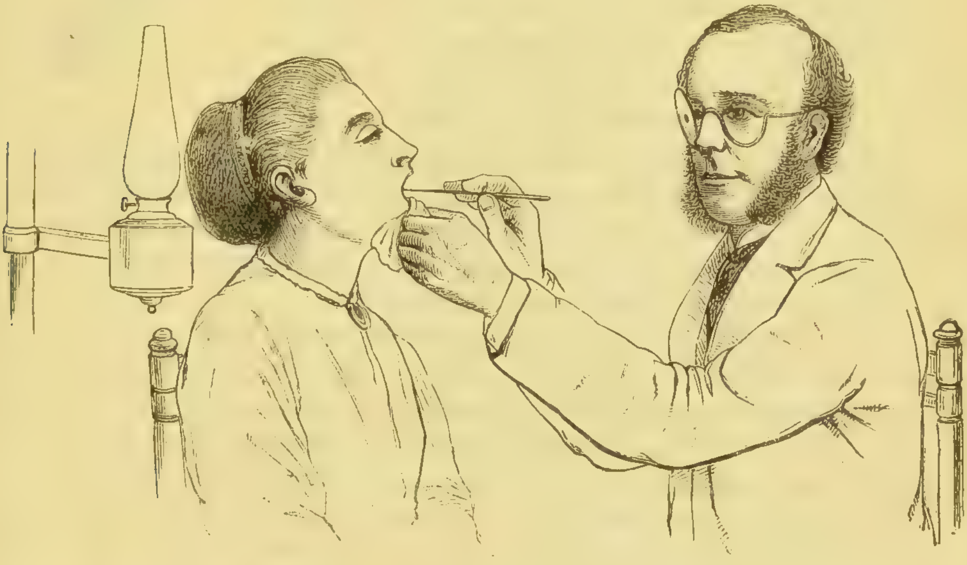


Fig. 761.—Method of using the Larygoscope with Reflector.

Laryngoscope. The introduction of this instrument into practice and its perfection have been a work of time. It appears to have been invented and first used in 1829, by Babington, who, under the term "Glottiscope," described an instrument consisting of a small mirror fixed to a wire shank, which, being placed against the palate whilst the tongue was held down, enabled him to view the glottis and upper part of the larynx; more especially when he illuminated these parts by throwing reflected light upon them from a mirror held in his left hand. Liston, Trousseau, and Avery all made attempts in the same direction. But it was the celebrated singer Garcia, who, in 1854, by throwing the sun's rays into the back of his mouth from a mirror held in his left hand, and then introducing a dentist's reflector into his mouth, saw the image of his own larynx and studied its movements in the reflection of the looking-glass. Hitherto, however, laryngoscopy had not been employed in the study and diagnosis of diseases of the larynx, and it is undoubtedly to Czermak that the merit is due of having been the first, in 1857, to make this application of the art.

The *laryngoscope* essentially consists of two instruments, a reflector (Fig. 761), which may be attached by a spectacle-frame or an elastic band to the Surgeon's forehead, and a mirror (Fig. 762), which is held in his right or left hand, according to circumstances. The mode of application and of use is illustrated in Fig. 761. The patient sits with his back to a good light; that of the sun does very well if it can be obtained, but usually artificial light has to be employed. This may be obtained from a moderator or paraffin lamp. The flame of the lamp should be a little above the level of the patient's ear. The Surgeon, facing the light, arranges the reflector in such a way that, whilst both he and the patient are in easy positions, a well defined circle of light covers the patient's mouth. If, as in many arrangements, the reflector be over one eye of the Surgeon, he must so place it that he sees clearly through the hole in the centre, and can consequently employ both eyes in examining the throat. The patient now having the head very slightly inclined backward, opens his mouth and puts out his tongue. The Surgeon grasps the tip of the tongue gently between the fore-finger and thumb of his left hand, covered by a cloth or pocket-handkerchief. He must be careful not to drag on the tongue, but merely to hold it steady, supporting it underneath and keeping it from being hurt by the lower teeth, by the forefinger passed across its under surface. He now takes the small mirror and warms it over the lamp, so that the patient's breath may not condense on it and obscure the image of the larynx. Having warmed it till he sees the cloud of condensed moisture from the lamp disappear, he tests it against his own cheek to feel that it is not too hot, and then introduces it in the following way. The handle being held like a pen, and rather to the left side of the patient's mouth, the mirror is passed in carefully, having its surface parallel to the dorsum of the tongue, until the tip of the uvula rests on its back, and is pushed slightly backwards and upwards by it. Care must be taken in doing this that the reflecting surface does not touch the tongue, and so become dirtied, and that the mirror is not passed so far as to touch the back of the pharynx, which in most patients would cause an effort at swallowing. The mirror being in the position above described, the Surgeon will, if he see anything, view the back of the pharynx reflected on its surface; but, by gently and steadily raising his hand, so as to render the angle formed by the surface of the mirror with the patient's body about half a right angle, he will bring the opening of the glottis into view. By raising the hand still a little further, he can examine the epiglottis and the root of the tongue. It must be remembered that the image thus produced is reversed in the antero-posterior

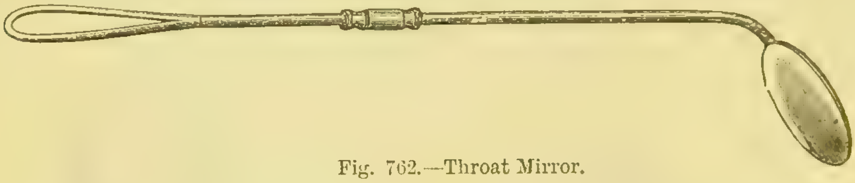


Fig. 762.—Throat Mirror.

direction, the parts that appear anterior on the mirror being really posterior; while in the transverse direction there is no reversal.

When the Surgeon requires both hands, as in the application of caustics or in the removal of growths or foreign bodies, the patient must be made to hold his own tongue, or it must be held by an assistant. The Surgeon then holds the small mirror in his left hand, and the instrument he is using in the throat in his right. Sometimes all view of the larynx is obscured by the patient obstinately arching the tongue in the mouth. It must then be held down by a spatula. In some patients, the fauces are so irritable that the slightest touch causes violent retching. This may be completely overcome by painting the fauces with a 20 per cent. solution of cocaine about five minutes before the examination is made, or, if this be not at hand, it may be allayed by sucking ice for a short time.

Laryngitis.—Inflammation of the larynx occurs both in adults and children, though more commonly in the former, from exposure to cold, and various other causes. It differs essentially from croup or diphtheria, which is attended by a fibrinous exudation, and spreads downwards into the bronchi; whilst in laryngitis there is no such effusion, and the disease is confined to the larynx itself. Laryngitis may not only be of an acute or a chronic kind, but the acute form likewise presents two distinct varieties, according to the parts affected, the cause from which it arises, and the condition of constitution in which it occurs: in one, the true **Acute Catarrhal Laryngitis**, the inflammation is seated chiefly in the mucous membrane; in the other, the **Œdematous Laryngitis**, the affection extends to the submucous areolar tissue, within and around the larynx.

In all inflammatory affections of the larynx, whether acute or chronic, there is danger to life; the narrow chink of the rima glottidis becomes rapidly occluded, and asphyxia consequently results. This may happen either by the swelling of loose folds of mucous membrane about the upper opening of the glottis; from membranous exudation upon the vocal cords; or by the occurrence of spasm in the larynx. Indeed, there is usually more or less spasm conjoined with all the acute inflammatory affections of this part of the air-tube; and this spasm, being superadded to already existing mechanical occlusion, commonly proves fatal. The spasms do not at first recur oftener than at intervals of half an hour or an hour; but as the disease advances they become more frequent, and in any one of them the patient may be carried off. It is of importance to bear in mind that death may occur in these cases, although a considerable portion of the opening of the glottis is free for the transmission of air; and that death must consequently result from some cause other than mere mechanical obstruction. This freedom from permanent occlusion commonly occurs in cases of laryngitis; and the immediate cause of death in the majority of instances appears to be spasm, conjoined with defective arterialization of the blood, which causes congestion of the lungs and convulsions.

Acute Catarrhal Laryngitis may arise from exposure to cold, from violent strains of the vocal apparatus, or from extension of catarrh from the nose or pharynx. It is most common in adult males, but may occur in children. One attack predisposes to another. The mucous membrane only being affected, the *symptoms* are not indicative of such early and intense interference with respiration as is met with in the œdematous form of the disease. These are dryness of the throat and hoarseness, with pain varying from mere tickling to a severe sense of constriction. Occasionally there are pain and tenderness on pressing upon the larynx, more especially about the pomum Adami. The voice is at first harsh and rough, then stridulous, and finally may be completely lost ; there may be some pain and difficulty in deglutition. In simple catarrhal laryngitis there is rarely any serious dyspnœa or spasm, but in children there may be considerable difficulty in respiration, especially if the glottis becomes covered with dried mucus during sleep. There is expectoration of frothy mucus, sometimes tinged with blood, and the act of coughing is accompanied by considerable pain. With the laryngoscope the intensely injected state of the mucous membrane of the larynx can be seen ; but this is not accomplished without difficulty, partly from the irritability of the fauces, and partly from the large amount of tenacious mucus which usually surrounds the glottis. In very severe cases the inflammation may extend to the submucous tissue, and be accompanied by exudation into the loose areolar tissue, and the symptoms then gradually merge into those of the œdematous form of laryngitis to be presently described.

Treatment.—The patient should be placed in a warm atmosphere, which should be kept moist by steam carried into the room from the spout of a kettle. This is especially important in children, to prevent the drying of the mucus during sleep. Hot fomentations may be applied to the throat, and the patient should be made to inhale the steam from a pint of hot water, to which a teaspoonful of compound tincture of benzoin has been added. A free purge will generally be found useful at the onset of the attack, and should there be much pain and cough small doses of opium should be administered. Should symptoms of dyspnœa appear, indicating a tendency for the inflammation to assume the œdematous form, more active measures must be adopted, which will be described with that affection.

Acute Œdematous Laryngitis may arise as an intensification of simple catarrhal inflammation, as an independent affection by extension from neighbouring parts, or as a complication of various chronic affections of the larynx. In many cases it seems to be distinctly erysipelatous in character, occurring as the result of exposure to the impure air of crowded hospitals, to sewer gas, or to the specific infection of erysipelas. In fact it appears to be at times epidemic, and in its pathological conditions to resemble closely phlegmonous erysipelas of the part, the mucous membrane becoming red, pulpy, and swollen, and the submucous tissue infiltrated with sero-purulent fluid. Œdematous laryngitis is occasionally met with in fevers, especially in scarlet fever, and it is predisposed to in some cases by Bright's disease. It is most commonly met with in adults, being very rare before the age of eighteen. The *symptoms* are usually well marked. The fauces are reddened, dusky, and swollen ; difficulty in swallowing is often an early and prominent symptom, and continues throughout ; dyspnœa, often of a spasmodic character, then appears, the lips becoming livid, the nostrils dilated, the features pale and bedewed with perspiration, the eyes watery and bloodshot, and the respiratory muscles are called into violent action ; gasping efforts at breathing and sudden fits of increased difficulty in inspiring come on ; at the same time the pulse is feeble, though it continues rapid ; and, unless efficiently relieved, the patient will speedily sink. The voice is at first hoarse, but is speedily lost, and there may be some tenderness about the larynx. The dyspnœa is usually peculiar in character in the intervals between the spasms. Inspiration is always more or less difficult, as the swollen œdematous parts fall together in a valve-like manner over the opening of the glottis. Expiration, on the other hand, may be comparatively easy. The fatal result is frequently due directly to spasm. The spasms come on early, and are very apt to be brought on by speaking or swallowing; but as the disease advances the dyspnœa becomes more continuous, until stupor at length supervenes, and speedily terminates in death. There is usually well-marked febrile disturbance. If the finger be passed over the back of the tongue the rigid swollen epiglottis may be distinctly felt. Laryngoscopic examination shows the epiglottis forming a red semi-transparent roll, usually bent upon itself transversely. It may completely conceal the parts beneath, but in many cases the œdematous arytæno-epiglottidean folds may be seen on each side. It is rarely possible to obtain a view of the cords.

The œdematous infiltration in this form of laryngitis is confined principally to the submucous areolar tissue around the epiglottis, in the arytæno-epiglottidean folds, and over the arytænoid cartilages. In these situations the tissue is distended with an abundant inflammatory exudation, of an opalescent appearance, so that the swollen membrane may almost completely occlude the rima glottidis (Fig. 763). It is a pathological fact of much importance, that the effusion never extends below the true vocal cords, being limited at this point by the direct adhesion of the mucous membrane to the subjacent fibrous tissue, without the intervention of any loose areolar tissue.

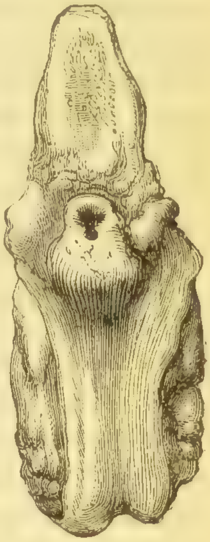


Fig. 763. — Acute Œdema of the Glottis.

Diagnosis.—It is of great importance to recognize œdematous laryngitis early, and not to confound it with simple catarrhal inflammation. The laryngoscope is of the greatest use in arriving at a correct diagnosis. It is somewhat difficult to use in these cases, especially if there be much dyspnœa, but supposing even a momentary glance be obtained of the opening of the glottis, the condition depicted in Fig. 763 may readily be recognized. In addition to this, the occasional epidemic character of the affection, the early dyspnœa, and the dusky swollen fauces will point to the œdematous variety.

Treatment.—The treatment should be antiphlogistic, though in many cases the constitution will not bear very active measures. Leeching under the jaws and over the larynx may be tried. In some cases aconite, antimony, or salines might be of use, but very often the invasion of the inflammation is so rapid that local means must be relied upon rather than constitutional. In many cases scarification with a hernia-knife, or with a sharp pointed bistoury, sheathed with plaster to within a quarter of an inch of its point, will be found the most ready means of unloading the infiltrated mucous membrane. The operation of scarification may be more accurately performed by using the laryngeal lancet, whilst the glottis is brought into view by the use of the laryngoscope. If no instrument be at hand, the swollen mucous membrane may be efficiently scarified with the forefinger-nail notched with a pair of scissors. After this, inhalations of the steam from a pint of hot water to which twenty drops of carbolic acid or a drachm of compound tincture of benzoin has been added, will be found to give most relief. Hot fomentations must be applied externally and frequently changed. In the early stages ice may be given, but after the swelling has commenced steaming the throat usually gives more relief. If, notwithstanding these remedies, the difficulty in respiration continues to increase, the windpipe must be opened before the lungs and brain become irretrievably engorged. After the proper employment of the means that have been indicated and their failure, the less delay there is in opening the air-passage through the crico-thyroid membrane, the better. The Surgeon should not wait until extreme and continuous dyspnœa has set in; this may never occur, the difficulty in breathing being rather spasmodic than continuous, and in one of the spasms of dyspnœa life may suddenly become extinct. The lungs may become fatally congested, if the difficulty in breathing be allowed to continue too long. The operation adds but little to the patient's danger, but the increased risk is immense if it be delayed to an advanced period. I can truly say that I have seen several cases lost by delaying the performance of the operation, but never one by operating too early. When once dyspnœa with laryngeal spasm has fairly set in, every moment is precious, and the patient may at any time be carried off by the recurrence of the spasmodic seizures. The patient does not die gradually asphyxiated, but is suddenly seized with a spasm that terminates his existence. Macewen first suggested that instead of performing tracheotomy a large catheter should be passed through the larynx from the mouth. He successfully adopted this mode of treatment in one case, retaining the catheter with surprisingly little inconvenience to the patient till the œdema had subsided. "Intubation" has since become a recognized alternative to tracheotomy.

In some cases sloughing and putrid suppuration of the submucous areolar tissue may occur, as in phlegmonous erysipelas of other parts of the body, and the patient may die partly from asphyxia and partly from blood-poisoning. In these cases the administration of stimulants and tonics, more particularly port-wine and bark, with free sponging of the part with a strong solution of nitrate of silver, will be urgently required.

Traumatic Laryngitis from scalds, corrosive fluids, &c., has already been alluded to. It usually assumes the œdematous form, and requires the same treatment.

Chronic Laryngitis.—The larynx is liable to various chronic diseases of a serious character, some of which are incurable, leaving a permanent impairment of the vocal and other functions of the larynx. Chronic laryngitis is usually divided into three varieties, Simple or Catarrhal, Syphilitic, and Tubercular. All forms give rise to interference with the voice, and some to Aphonia, or complete loss of voice.

Simple Chronic Laryngitis.—This affection is common amongst those who habitually exert the voice, and from its frequency amongst clergymen is familiarly known as the *Clergyman's Throat;* it is also of frequent occurrence amongst singers, but may be met with in all classes of the community. In some cases it is the result of a previous attack of acute laryngitis, and it is predisposed to by gout and alcoholic excesses. The voice at first becomes hoarse, and may at last be reduced to a whisper. There is a slightly increased secretion of mucus, but it is never abundant. The patient is constantly troubled by a tickling or spasmodic cough, and at the same time there is usually a feeling as if there were some constant cause of irritation in the throat, attended by a desire to cough up and expectorate. Laryngoscopic examination shows diffused redness, with here and there ramiform injection of the vessels. The true vocal cords have lost their sharp edges, and are somewhat rounded, and at the same time, instead of the pure white colour natural to them, they are usually of a pink tint. Occasionally small wart-like growths or minute superficial erosions may appear on the vocal cords or on other parts of the glottis, as the result of simple chronic laryngitis. In many cases the appearances may be more or less obscured by adherent pellets of tough mucus.

Treatment.—The treatment of simple chronic laryngitis requires to be conducted by careful regulation of the general health and selection of climate, avoidance of exposure to cold, attention to digestion and diet, and rest of the parts. All loud or prolonged speaking should be strictly forbidden. In addition to this the local applications of various astringent vegetable and metallic solutions is of the greatest service.

In the milder forms of the disease, glycerine of tannin, applied by means of a camel's-hair brush, will be found useful. In many cases the best results follow the inhalation of solutions of tannin or sulphate of zinc in a "pulverized" form, applied by means of the ordinary spray-douche, such as is used for procuring anæsthesia by the local application of ether. Mackenzie recommends insufflations of pale powdered catechu with bismuth and a little morphia, and when this does not make much impression, insufflation of eucalyptus (red gum) powder. But of all these astringents none is more useful than a **solution of the nitrate of silver** (5 gr. to ℥j), which may be looked upon almost as specific in the simpler forms of this disease.

The practice of treating chronic disease of the larynx by the application of a strong solution of the nitrate of silver is by no means of recent origin. Many years ago it was employed by Sir C. Bell: and before him Bretonneau applied the solution in these cases by means of a sponge attached to a piece of whale-bone. Subsequently the practice was brought very prominently before the profession by Trousseau, and by the American Surgeons, especially Horace Green and J. Warren. Of the great value of this treatment there can be no doubt. Other astringents are preferred by some Surgeons at the present time, as causing less spasm of the glottis when applied; thus Mackenzie uses perchloride of iron (ʒj to ℥j), chloride of zinc (gr. x. to ℥j). Astringent solutions must be accurately applied to the inflamed part by the help of the laryngoscope. This was formerly done by means of a small sponge firmly attached to a curved whale-bone stick (Fig. 764), and special holders have also been devised, so that a fresh piece of sponge may be used for each patient. At the present time sponges are rarely used, a large camel's-hair pencil, attached to a piece of wire bent to the proper angle, and set in a handle, being far more convenient and efficient (Fig. 765). As the brush is applied the patient should be made to say "ah," so as to raise the epiglottis, and the Surgeon should actually see the brush go behind it. In the absence of the

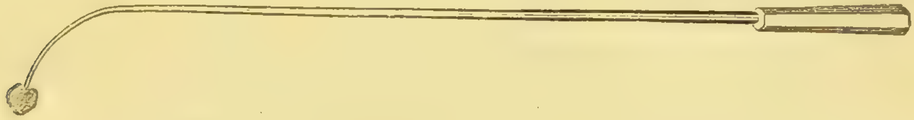


Fig. 764.—Sponge for applying astringent solutions to the larynx.

laryngoscope, if the tongue be well depressed with a proper spatula, the solution may be applied after a little practice with almost equal certainty. Guided by the laryngoscope, the brush may be momentarily passed between the vocal cords, but the spasm so caused renders it impossible to do more.

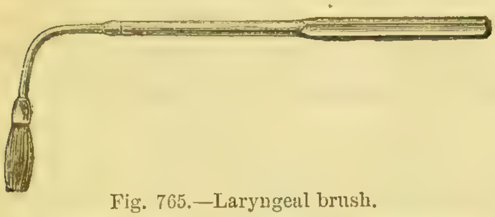


Fig. 765.—Laryngeal brush.

Inhalation of the Nitrate of Silver in Powder is occasionally useful in cases in which the follicles about the opening of the glottis are much enlarged. It is most conveniently done by mixing it, in proper proportions, with some innocuous impalpable powder, such as ground and dried sugar. The strength may vary, one part of nitrate of silver being mixed with twelve, sixteen, or twenty of sugar. A small quantity of the powder so prepared should be put into the end of a thick glass tube, which has been bent nearly at right angles about one inch from its extremity. The Surgeon, placing his finger over the orifice of the straight part of the tube, carries the bent end behind the tongue, over the epiglottis ; he then directs the patient to make a sudden inspiration, and at the moment of his doing so takes away his thumb, so as to allow the powder to be drawn out of the tube and into the air-passages along with the current of inspired air. In this way the nitrate of silver may, in some cases, be very conveniently applied to the whole of the affected mucous surfaces.

Injection of the Solution of Nitrate of Silver may easily be done by means of the instrument that is here delineated (Fig. 766), and which I have had constructed for this purpose. It consists of a silver tube, perforated at the end, and having a small piston moving in it with a sponge attached to its lower surface. The instrument is charged by dipping the end in the solution, and then drawing back the piston-rod. It is then passed into the pharynx, or between the lips of the glottis, and the fluid is injected into the air-passages or upon the inflamed surfaces in a number of fine streams, by pushing down the piston and compressing the sponge. By means of this *laryngeal syringe* the nitrate of silver can be applied to any part of the pharynx, without irritating the tender mucous membrane by the contact of a rough body ; and, by applying its nozzle to or between the lips of the glottis the fluid may be readily thrown down into the interior of the larynx with the greatest certainty and ease. In those cases in which it is wished to apply the solution of the nitrate of silver to the air-passage, I greatly prefer using this simple instrument to the ordinary brush, the mere pressure of which upon a tender mucous surface may be a source of irritation. When the mucous membrane behind the velum, or that of the posterior nares, is affected, the solution may readily be applied to these parts by turning the end of the instrument upwards, and then injecting it directly on to the affected surfaces.

Fig. 766.—Laryngeal Syringe

In whatever way the caustic is used, its application should be repeated about every second or third day, in order to insure its full effects. In some instances, however, advantages may be obtained by using it every day; in others, again, a longer interval is required than that just stated.

Syphilitic Laryngitis.—According to Sir M. Mackenzie, syphilitic disease forms about 3 per cent. of all affections of the larynx. In the early exanthematous stage of syphilis, slight hyperæmia, with a little hoarseness, is not uncommon, but it is usually so slight as to pass unnoticed. In the later secondary stages, condylomata or mucous tubercles may be met with. They can be recognized only by the laryngoscope, by means of which they can be seen forming smooth greyish elevations, usually on the epiglottis or the inter-arytænoid fold of mucous membrane. These may be followed by superficial ulceration. The most common and characteristic of the syphilitic affections of the larynx are those met with in the tertiary stages of the disease. The pathological changes observed are the same as in other parts—diffuse overgrowth of the connective tissue or gummatous infiltration, and the formation of isolated gummata. The subsequent softening of the gummata gives rise to widespreading, destructive ulceration, and should the patient recover and the ulcers heal, cicatricial contraction follows, sometimes to such an extent as almost to close the opening of the larynx. The parts first affected are usually the epiglottis and the arytæno-epiglottidean folds, and from these points the ulceration extends inwards towards the glottis. Sometimes the distinct gummata may be seen as pale yellowish elevations in the mucous membrane, and should softening and ulceration follow, the yellowish adherent slough may possibly be recognized. Syphilitic ulceration not uncommonly leads to complete destruction of the epiglottis, and in the later stages necrosis of the cartilages frequently occurs. The disease is usually associated with similar ulceration in the pharynx. The symptoms are those of chronic laryngitis, with muco-purulent expectoration and gradual loss of voice. Gradually increasing dyspnœa is not uncommon from contraction of the opening of the glottis.

Diagnosis.—Syphilitic ulceration of the larynx is recognized by the history of syphilis and the presence of other manifestations of the disease, by the rigidity of the affected tissues, by the early affection of the epiglottis, the foul grey surface of the ulcers, or the presence of adherent yellow sloughs, and by the fact that the ulceration commences in the peripheral parts, and spreads towards the central. The rapidity with which the destruction of tissue may take place serves to distinguish it from epithelioma.

Treatment.—The usual constitutional treatment of syphilis must be actively adopted. Locally a solution of bichloride of mercury (gr. ij. to ℥j.), may be applied with a sponge or brush, or a preparation of half that strength used as a spray. Iodoform mixed with twice its bulk of starch may be blown into the larynx by the method already described, or by means of the special instrument constructed for this purpose. When healing is taking place nitrate of silver may be of use, but it is not so efficacious as in simple chronic laryngitis. Should the dyspnœa become a marked symptom, tracheotomy must be performed.

Tubercular Laryngitis is usually met with only in advanced disease of the lungs, but occasionally it is the earliest sign of phthisis, and the disease may run its course and terminate fatally without the lungs being extensively affected. This variety is sometimes spoken of as *Laryngeal Phthisis.* The earliest symptoms are merely those of chronic laryngitis. As it advances the voice is lost, there is constant cough, with frothy muco-purulent expectoration and great pain. Deglutition becomes gradually more and more painful, till at last the patient can scarcely be induced to swallow, and death takes place gradually from exhaustion. Laryngoscopic examination may at first show nothing more than marked anæmia of the whole of the larynx without any definite lesion. This should always be looked upon as a suspicious sign, and proper precautionary measures should be taken without delay. Before long, however, a peculiar swelling is observed in the mucous membrane covering the arytænoid cartilages and the neighbouring parts of the arytæno-epiglottidean folds. This gives rise to two pyriform swellings of sufficient size to meet in the middle line posteriorly. It is this swollen mass projecting backwards that causes the pain and difficulty in swallowing. Numerous small ulcers then appear, first in the central parts, and subsequently extending to the peripheral. The under surface of the epiglottis may be early affected. These ulcers gradually coalesce and extend, forming crenulated sores, destroying the vocal cords and neighbouring parts. There is seldom serious dyspnœa, as the sores have no tendency to heal and contract. In the later stages, if the patient survive sufficiently long, necrosis of the cartilages may take place.

The *Diagnosis* is made by the presence of disease of the lungs, the peculiar swelling over the arytænoid cartilages, by the multiplicity of the ulcers and their comparatively superficial character, and by the fact that they appear first in the central parts of the larynx and spread towards the peripheral. One very characteristic mark in pronounced cases is that the whole of the inside of the larynx seems bathed in an abundant creamy secretion.

The *Treatment* of this affection belongs rather to the physician than the Surgeon. Local treatment can at most give some slight relief. Mackenzie recommends soothing inhalations, such as the compound tincture of benzoin, or the insufflation of from one-eighth to one-fourth of a grain of morphia diluted with starch and oxychlorate of bismuth, twice a day. From half a grain to a grain of iodoform may advantageously be added. Good results have been obtained by Heryng of Warsaw, and H. Krause of Berlin, by applying lactic acid to the parts with a sponge. This is said to keep the ulcers clean, and even to cause cicatrization. The dyspnœa is rarely such as to necessitate tracheotomy. The difficulty in swallowing when due merely to pain may be relieved by the application of a 20 per cent. solution of cocaine to the larynx by means of a brush, or a 4 per cent. solution in spray with an ordinary spray-producer, before a meal. If it arises from the food finding its way into the larynx the patient must be fed by means of a tube, the passage of which may be facilitated by the application of cocaine.

Complications of Chronic Laryngitis.—In all cases of chronic laryngitis there is a tendency to *acute inflammation* supervening on the chronic disease. The affection may then prove fatal by the induction of œdema glottidis, often coming on with great rapidity. *Necrosis of the Cartilages of the Larynx* is most commonly a complication of the more advanced stages of tubercular laryngitis, and less frequently of syphilitic disease. It has been known in rare cases to follow typhoid fever, and still more rarely to occur without any evident cause. It gives rise to copious expectoration of large quantities of fœtid puriform sputa, often streaked with blood, and occasionally containing masses of necrosed and usually calcified cartilage. In many cases abscesses form outside the tube, and after much irritation and distress open externally; and not unfrequently they are met with to such an extent, as to undermine and disorganize the greater portion of the tissues of the anterior part of the neck. Where they correspond to the necrosed patches of cartilage, they give rise to aërial fistulæ, through which bubbles of air escape during respiration. Tracheotomy is sometimes required in these cases.

In cases of long-standing laryngeal disease, either syphilitic or tubercular, it has been proposed by Bryant to perform tracheotomy with the view of giving the diseased organ rest, the operation being undertaken, not for the relief of laryngeal obstruction, but with the object of aiding other curative means in an otherwise intractable disease. This suggestion appears to be founded on sound principles, and is of peculiar importance when we consider that patients suffering from chronic laryngeal disease are never safe from the sudden supervention of œdema glottidis. Whenever acute inflammation supervenes, with a tendency to œdema about the glottis, the patient should be narrowly watched, as he may be carried off by the sudden swelling of the lips of the rima, or by the occurrence of spasm. In such cases tracheotomy may have to be performed; and this must not be delayed until the patient falls into an asphyxial condition.

Nervous Affections of the Larynx occur both in children and in adults. In *children* the affection, commonly called **Spasmodic Croup**, comes on suddenly and runs its course with great rapidity. The child is seized, often without previous warning, with difficulty in breathing, makes violent efforts to inspire, becomes black in the face and convulsed, and has in rare cases been known to die before anything can be done for his relief; but ordinarily he gapes and gasps a few times, and eventually recovers himself with a long deep-drawn whooping inspiration. In cases of this kind, the *Treatment* at the time of the fit consists in dashing cold water in the face, in exposing the body to a current of cold air, and in using friction to the extremities. If asphyxia occur, artificial respiration must be kept up either through an opening made in the windpipe or by the mouth.

In the *adult*, these spasmodic affections of the larynx may come on either from pure hysteria, or from irritation of the laryngeal nerves by the pressure of tumours or aneurisms upon them. In other instances they arise from the presence of some local inflammatory mischief about the glottis. In the hysterical form of the affection the ordinary remedies for hysteria, together with cold douches, will be of essential service. When the disease arises from irritation to the trunks of the nerves tracheotomy may give relief, but the cause of the pressure on the nerves is usually in itself of a fatal character.

Paralysis of the Larynx, either unilateral or bilateral, is occasionally met with. When unilateral, it arises usually from pressure on the recurrent laryngeal nerve by an aneurism or other tumour. The abductor muscles of the cords are usually affected first. The vocal cord on the affected side then remains stationary in the adducted position. If only one side is affected it causes some alteration in the voice, but no serious dyspnœa. If both sides are affected from any cause serious dyspnœa results, necessitating tracheotomy for its relief. Many other forms of paralysis of the muscles of the larynx are met with, but their consideration belongs to the physician.

Tumours of the Larynx.—Simple Tumours.—*Papillomata* form the most common simple tumours of the larynx. They appear as cauliflower-like growths of all sizes up to that of a walnut. They may be single and pedunculated, or multiple and sessile, spreading widely over the upper opening of the glottis. Their most common seat of origin is the vocal cords. They are met with at any age, but are more common after thirty than before. In structure they resemble similar growths elsewhere, being composed of processes of vascular connective tissue covered with a layer of epithelium. The epithelium is that normal to the part, being, as a rule, squamous, though columnar epithelium is said to have been occasionally observed. *Fibromata* are much less common. They form rounded or smoothly lobulated pedunculated growths, springing usually from the neighbourhood of the vocal cords. They are almost invariably single. They are composed of ordinary fibrous tissue, covered with a squamous epithelium. *Myxoma, Lipoma,* and *Nævoid Tumours* have been met with, but are of extreme rarity. *Cysts* arising from retention of the secretion of the mucous glands occasionally develop in the neighbourhood of the epiglottis or false vocal cords. They form smooth, shining, rounded projections. *Polypus of the Larynx* is a term applied to any pedunculated growth, and has no pathological significance.

The simple tumours of the larynx cause alteration in the voice, slight cough, discomfort, and dyspnœa, varying in degree with the size of the growth. Their true nature can be recognized only by careful examination with the laryngoscope.

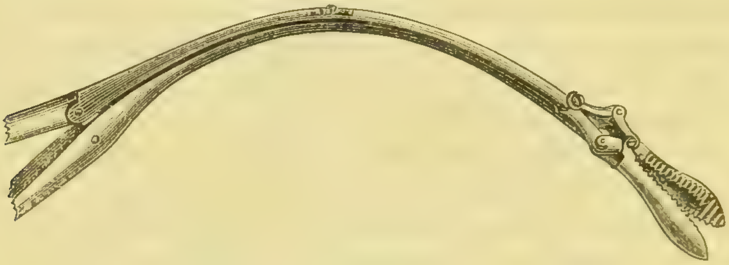


Fig. 767.—Endo-laryngeal Forceps.

Treatment.—These growths may be removed by one of two methods—the endo- or the ecto-laryngeal. There appears to be a general consensus of opinion amongst laryngologists that the endo-laryngeal method should always be attempted in the first instance. Should it fail, then the larynx may be opened and the growth removed from without. The endo-laryngeal method consists in removing the growth through the glottis by means of instruments specially designed for the purpose, guided by the laryngoscope. The instruments most commonly used are forceps, by which the growth can be seized and torn from its attachments ; but in some cases, especially when the growth is of some size and distinctly pedunculated, wire snares or small écraseurs may be of use. In some cases the destruction of the growth may be brought about by simply crushing it with a strong pair of forceps. These operations have been greatly facilitated by the use of cocaine, but still require practice both on the part of the patient and the Surgeon. The patient must be taught to keep steady, to hold his own tongue, and to tolerate the presence of the instrument. For this purpose it is often necessary to train him for a week or two before any real attempt is made to remove the growth. The smaller papillary growths will sometimes disappear under the application of nitrate of silver ; in such cases therefore the Surgeon should not be in a hurry to attempt operative interference. The accompanying drawings (Figs. 767, 768, 769) show various forms of forceps which may be used in these operations.

Should the endo-laryngeal operation fail or be impossible, the growth must be removed by an ecto-laryngeal operation. Sir M. Mackenzie lays it down as a cardinal rule that no operation of this kind should be undertaken unless there is danger to life from dyspnœa or dysphagia.

The operation most commonly performed is that known as **Thyrotomy.** It is advisable in most cases to perform a preliminary tracheotomy about a fortnight before undertaking the removal of the tumour. When the patient has quite recovered from this and feels no further discomfort from the tube, thyrotomy may be undertaken. The operation is thus performed : an incision is made accurately in the middle line from the thyroid notch to the cricoid cartilage. The cartilage is then carefully divided with a knife, or, if it be ossified, with a fine saw. The alæ are then held apart with blunt hooks and the interior of the larynx is fully exposed. A small piece of sponge may then be passed into the trachea so as to plug the opening above the tube, lest blood should pass into the lungs. The morbid growth may then be removed with scissors, and the surface from which it grew touched with nitrate of silver. After all bleeding has ceased the sponge is removed, and the parts accurately brought together, and the trachea-tube is retained until the patient can breathe through the glottis with ease. Mackenzie has published the results of 48 cases, collected from various sources. Of these 8·33 per cent. died, in 31·25 per cent. the operation was followed by persistent dyspnœa, requiring the use of the cannula, and only 14·58 per cent. resulted in recovery of perfect voice and perfect respiration.

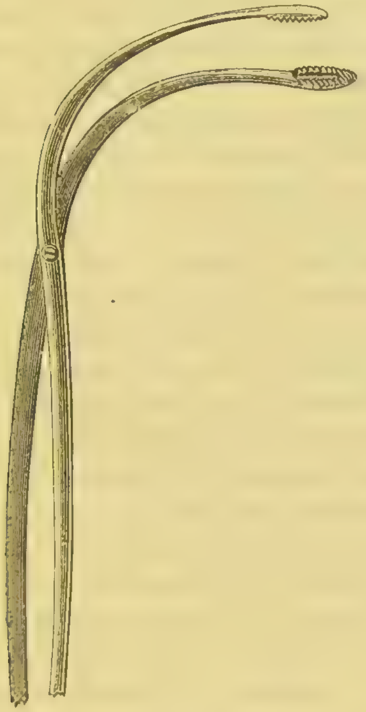


Fig. 768.—Endo-laryngeal Forceps.

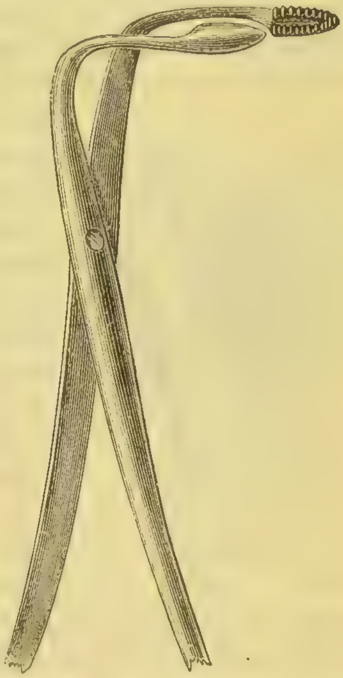


Fig. 769.—Endo-laryngeal Forceps.

Tumours affecting the upper opening of the glottis or the epiglottis have also been removed by a transverse incision in the thyro-hyoid space. Malgaigne recommends that the incision should be made along the lower border of the hyoid bone, partially dividing the sterno-hyoid and sterno-thyroid muscles and the thyro-hyoid membrane. The head being thrown well back, sufficient space may thus be obtained to allow of removal of the epiglottis or a tumour situated in its immediate neighbourhood. This operation can seldom be required, as simple growths in this region can usually be removed from the mouth.

Malignant Tumours of the Larynx.—Both true carcinoma and sarcoma are met with in the larynx, but the former is far more common. The form of carcinoma met with is almost invariably squamous epithelioma. Columnar epithelioma has, however, been observed, and scirrhous glandular cancer is said to have been seen. When sarcoma occurs in the larynx it is most commonly spindle-celled, less frequently round-celled or mixed. Butlin, who has collected the records of 23 cases of sarcoma, states that half the cases were spindle-celled. Malignant growths in the larynx may be intrinsic or extrinsic, that is to say, they may commence in the interior of the larynx, or spring from surrounding parts and secondarily invade it. All malignant growths in this region tend to assume a papillary form (Fig. 770), though they are rarely polypoid. They are most commonly single. The symptoms they give rise to are those of interference with speech and respiration, with some cough and expectoration, often mixed with blood. In the carcinomatous growths the glands are affected late in the disease, and often escape altogether. The situation of the tumour and its size are usually determined without difficulty by the laryngoscope, but it is not easy in many cases to determine the nature of the growth. For this purpose a piece of the growth can sometimes be removed with the laryngeal forceps, and submitted to microscopic examination. If the fragment so removed presents undoubted evidence of cancer, the diagnosis is made, but if not, great doubt will still exist as to the nature of the disease, for it not uncommonly happens that a malignant growth in this region is surrounded by a warty fringe presenting the structure of a simple papilloma. Death, in cancer of the larynx, is inevitable, either by asphyxia or by constitutional infection, if the disease be left to run its course ; and up to a comparatively recent period the Surgeon had no other means of prolonging life than by the performance of tracheotomy. Of late years, however, Operative Surgery has added extirpation of the entire larynx to its other triumphs.

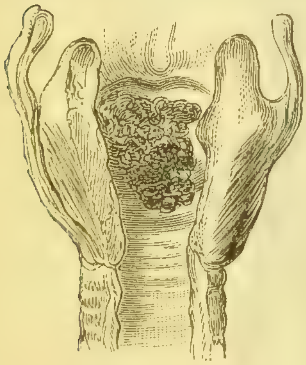


Fig. 770.—Epithelioma in Larynx.

Extirpation of the Larynx.—Excision of the larynx, or *laryngectomy*, in part or in whole, has been somewhat extensively practised of late years. The first case in which this formidable operation was undertaken was that of a man 35 years of age affected with syphilitic stenosis of the larynx. Dr. P. Heron Watson in 1866 excised the larynx in this case, the patient dying three weeks afterwards of pneumonia. In 1873 Billroth operated in a case of carcinoma of the larynx. The patient survived the operation, but died in a few months from recurrence of the disease. Since this time the operation has been frequently practised. Solis Cohen collected the details of 65 cases of complete removal of the larynx, and Hahn has increased the number to 74.

Excision of the larynx can only be of advantage to the patient in well selected cases in which the diagnosis has been made early. When the disease is extrinsic and is invading the epiglottis and possibly the root of the tongue, or when having been originally intrinsic it has spread beyond the limits of the larynx, no good can be expected from the operation. Even if the patient survives, recurrence will certainly take place, and it is probable life would be equally prolonged and greater comfort secured by the simple operation of tracheotomy.

The **Operation** must be varied somewhat according to the extent of the disease, but the following plan recommended by Foulis is applicable to most cases. A vertical incision must be made accurately in the middle line from the body of the hyoid bone to the second ring of the trachea. The soft parts are then to be turned off the larynx, all bleeding vessels being ligatured as they are cut. When the larynx is fully exposed and all bleeding arrested, the cricoid cartilage is drawn forwards with a sharp hook and the trachea divided, care being taken not to wound the œsophagus. The trachea is then at once plugged with a large vulcanite or leaden tube, slightly conical in shape and completely filling the passage. Several such tubes of different sizes should be at hand. The larynx is then drawn forwards and separated from the œsophagus and the lower part of the pharynx, the edge of the knife being carefully turned towards the parts to be removed. When all hæmorrhage has ceased the wound may be partly closed, the tube being retained in the trachea.

Hahn and many other Surgeons prefer to perform a preliminary tracheotomy, allowing some days to intervene before completing the operation if the patient is exhausted by previous dyspnœa or from imperfect nutrition. The trachea at the time of the operation may be plugged by Trendelenburg's tube (Fig. 694) or by Hahn's cannula, the outer tube of which is surrounded by compressed sponge, which rapidly swells and completely plugs the air-tube. Hahn recommends a transverse incision parallel to the cornua of the hyoid bone in addition to the vertical incision already described. Blunt-pointed scissors will be found more convenient than the knife in separating the larynx from the surrounding parts. They must be kept as close as possible to the cartilages, numerous short snips being made, and any wounded vessels immediately secured.

When the operation is completed and all bleeding arrested, an india-rubber tube must be inserted into the œsophagus, through which the patient must be fed until healing is far advanced. The wound must be plugged with some absorbent antiseptic material sufficiently firmly to prevent any discharges from passing downwards into the trachea, and this must be changed periodically. The tracheotomy tube is necessarily retained as long as the patient survives. Gussenbauer invented an artificial larynx, which was improved by Foulis, containing a reed for the production of vocal sounds.

Partial Excision of the Larynx.—In intrinsic carcinoma or sarcoma of the larynx the thyroid cartilage should be split up the middle as in thyrotomy before removing any portion of it. The disease may then be found to be so situated that it may be completely taken away by removal of half the thyroid cartilage with the corresponding arytænoid cartilage or perhaps even less than this. The operation must be varied according to circumstances, care being taken to cut sufficiently widely around the disease to give the patient a chance of escaping recurrence.

Results.—The best statistics before the profession are those of Hahn, which have been carefully analysed by Butlin in his work on Operation in Malignant Disease. Hahn's table contains 74 cases of complete excision of the larynx, 3 of which must be excluded as not having been performed for malignant disease. Of the remaining 71 cases 6 were for sarcoma, and 65 for cancer. Of the 6 cases of sarcoma, none died directly from the operation ; 1 was lost sight of after recovery ; in 2 recurrence took place under 15 months ; 1 died of phthisis 18 months after without recurrence ; 1 was quite well 6 years, and the remaining case 2 years after the operation. Of 2 partial excisions for sarcoma 1 died in 10 months of recurrence, and 1 was doubtful.

Of the 65 cases of complete excision for cancer, 30 were fatal from the effects of the operation, a few from shock, but the great majority from septic broncho-pneumonia. In 20 death from recurrence took place in a few months. Of the remaining 15 cases, the history of 1 was unknown, 2 died of pneumonia at 3 and 4 months, 7 were alive 14, 15, 16, 17, 18, 19 months and 4 years after the operation, and five were alive less than one year after. The condition of the survivors has in many cases been most miserable, owing to the great difficulty in deglutition, the food escaping from the open wound.

Life may be bought at too high a price—and surely death is preferable to such an existence as this, harassed by the constant dread of the inevitable return of that disease for escape from which the larynx has been excised—but in vain.

In Hahn's tables are 7 cases of partial removal for cancer, to which Butlin adds three. Only one died directly from the operation, the cause being uncertain. In 3 recurrence took place at 3, 6, and 17 months ; of the remainder one was alive at 14 months, and the rest at various periods under one year. The condition as to comfort in the survivors was infinitely superior to that of the patients who had undergone complete excision, phonation and deglutition being good, and no tube being required in most cases.

These statistics show that at present the death-rate directly from excision of the whole larynx is very high, and that the prospect of cure is very small. It is possible by careful selection of cases and by better means of preventing septic broncho-pneumonia, that great improvement may be obtained in both these points. Partial excision, on the other hand, is a very successful operation so far as the immediate result is concerned, but the danger of recurrence is very great as in complete excision. It should, however, evidently be preferred to complete excision whenever the nature and seat of the disease allow of it. The operation should never be performed in cases of extrinsic cancer, or when intrinsic disease has extended to the surrounding parts. Laryngectomy, indeed, appears to offer no advantages over tracheotomy in such cases. By tracheotomy the patient is saved from the danger of immediate suffocation with little risk to life, and his subsequent existence will probably be passed in greater comfort and endure as long as it would in the face of the inevitably speedy recurrence of the carcinoma after complete extirpation of the larynx. The operation is clearly unjustifiable when the cervical glands are implicated.

CHAPTER LIX.

OPERATIONS ON THE AIR-TUBE AND ON THE CHEST.

LARYNGOTOMY AND TRACHEOTOMY.

THE windpipe may require to be opened to allow the formation of a temporary breathing aperture, in consequence of obstruction of the larynx by causes that are speedily removable ; or it may be necessary to establish a permanent opening in those forms of chronic laryngeal disease, in which the obstruction depends upon alterations of structure which are not remediable.

Among the conditions requiring *temporary aperture*, may be mentioned all acute inflammatory affections of the larynx that give rise to obstructive œdema of the glottis ; also traumatic conditions, such as the impaction of masses of food in the gullet, inducing asphyxia, and not capable of being immediately removed ; scalds of the rima glottidis ; the presence of foreign bodies in the air-passage ; and œdema of the glottis from wounds of the thyro-hyoid membrane. The establishment of a *permanent aperture* in the air-passage is required in chronic diseases of the larynx, attended by thickening of the mucous membrane, by abscess, or by necrosis of the cartilages, and in cases of epithelioma or warty growth of the larynx.

Opening the Windpipe in Membranous Laryngitis.—By membranous laryngitis is meant any form of inflammation of the larynx, accompanied by a coagulable exudation from the mucous membrane, forming a false membrane upon it, whether diphtheritic or not. It is not the place here to enter into the disputed point of the identity of croup and diphtheria. The exhaustive report of the able committee appointed by the Medico-Chirurgical Society in the year 1879 clearly demonstrates the fact that inflammation of the mucous membrane of the larynx with membranous exudation may arise, not only as a result of diphtheritic contagion, but as an accompaniment of measles, scarlatina, or typhoid, and occasionally from "various accidental causes of irritation—the inhalation of hot water or steam, the contact of acids, the presence of foreign bodies, and a cut throat." It seems possible also that a similar condition may arise from simple exposure to cold. To all these cases the term "membranous laryngitis" may be indiscriminately applied, as it merely expresses an anatomical fact without implying any theory. The committee made the excellent suggestion that *croup* should be used merely as a clinical term implying laryngeal obstruction, occurring with febrile symptoms in children, and not as indicating a special disease, of the existence of which there is no conclusive evidence. When the disease is evidently zymotic, and when the larynx is affected by extension from the throat, the term "diphtheria" is applied to it by common consent. Membranous laryngitis, from whatever cause arising, is a most fatal disease in childhood, at least 90 per cent. of those attacked dying, and a considerable proportion of the minority that escape owing their lives to the performance of tracheotomy. In acute catarrhal laryngitis, unattended by membranous exudation, tracheotomy is scarcely ever needed, the disease yielding to milder methods of treatment.

Owing to the frequent failure of tracheotomy to save the life of the patient in membranous laryngitis the propriety of the operation was at one time disputed. It is now universally acknowledged that the operation should be performed in all cases in which the obstruction is evidently in the larynx, care being taken to distinguish dyspnœa due to extension of the inflammation to the bronchi and lungs from true laryngeal obstruction. In diphtheria tracheotomy must necessarily fail to save life in many cases, as it merely wards off the immediate danger of death from asphyxia, and the disease runs its course uninfluenced by the operation and frequently proves fatal by extension to the bronchi and lungs, by exhaustion or by the sequelæ of the affection. By opening the windpipe, however, as Sir W. Jenner has justly observed, we save the patient from so terrible a death as that from asphyxia, and even if the disease is ultimately fatal, death occurs in a less distressing manner.

The necessity of the operation then being recognized it remains to consider the indications for performing it. Trousseau strongly advocated early tracheotomy before collapse of the lung had taken place to any extent, or the patient had become exhausted by the struggle for breath ; and nothing is more certain than that the operation is rarely successful if performed *in extremis.* It may be taken as a rule that, when the voice is lost or nearly lost, and there is evident laryngeal obstruction gradually increasing, the sooner tracheotomy is performed the better. The degree of obstruction is estimated by the recession of the chest walls during inspiration. If the lower ribs and epigastrium sink in with each inspiratory effort, it is wiser not to delay the operation. Sir William Jenner pointed out that implication of the larynx in diphtheria rarely occurs after the end of the first week.

Even when performed early, tracheotomy for diphtheria frequently fails to save life. In the Hospital for Sick Children in Paris it appears that the operation was performed in 215 cases during a period of five years, and of these only 47 recovered. Unless we assume that the disease, as occurring in Paris, is different from that we meet with here, it may fairly be doubted whether an operation which is in itself dangerous could have been necessary in many of these instances, and whether a large proportion of the children might not have recovered under ordinary medical treatment and without having recourse to surgical operation.

The prospect of saving life after opening the windpipe in cases of diphtheritia will greatly depend upon the age of the patient. Under two or even three years of age, recovery is extremely rare ; as age advances, the chance of life proportionately increases, and in adults the prospect of recovery is considerable. In many cases the patient will get great temporary benefit from the operation, and will appear to be doing well for several days, perhaps for eight, ten, or fourteen ; and then, to the great disappointment of the Surgeon, he will die, not from the effects of the operation, but from blood-poisoning or from extension of the disease to the bronchi and lungs.

In other forms of laryngeal obstruction not dependent on membranous laryngitis, there can be no question as to the propriety of the operation. No patient ought ever to be allowed to die from simple laryngeal obstruction, whether that be spasmodic or dependent on organic disease, without an attempt being made to save life by opening the windpipe. It is as unpermissible for a

Surgeon to allow a patient to die of laryngeal asphyxia without an attempt at relief by opening the windpipe, even though life appear to be extinct, as it would be to let him die of hæmorrhage without attempting to control the bleeding vessel.

Necessity for Promptitude.—When it has been determined to open the windpipe for acute disease, more especially supervening on chronic laryngitis, the less delay there is in having recourse to operation, the better; as the patient may at any moment be seized with laryngeal spasm, and be carried off. The operation ought always, however, to be completed, even though the patient have apparently expired before the windpipe has been opened; for resuscitation may, even in these extreme cases, be effected by artificial respiration. When life hangs on so slender a thread as it does in urgent cases of laryngeal obstruction, the first touch of the knife may cause a spasmodic seizure that may give rise to apparent death. It has twice happened to me to operate under such circumstances, and in both cases to be fortunate enough to save the patient's life. I was called many years ago to an elderly woman who was apparently dying from the supervention of acute upon chronic laryngeal disease. I lost no time in making an incision into the crico-thyroid membrane, but at the first touch of the knife she sank back, apparently dead. I immediately completed the operation, and introduced a large silver tube, through which the lungs were inflated; in the course of a few minutes, voluntary respiration recommenced, and the patient eventually recovered. She never, however, was able to breathe without the tube, which she wore to the end of her life. In another case to which I was hastily summoned by my friend Mr. Tweed, I found the patient, a young woman, in the last stage of asphyxia from acute disease of the larynx. I immediately proceeded to operate. As the patient's neck was short and thick, and the veins excessively turgid, there was profuse hæmorrhage on the first incisions being made; while we were waiting a minute or two until this would cease before opening the windpipe, the patient fell back and apparently expired. I lost no time in plunging the scalpel into the crico-thyroid membrane, and cutting down through the cricoid cartilage, so as to make a free aperture into the air-passage. On endeavouring to set up artificial respiration, I found the air-passages clogged with inspissated mucus, which prevented the entrance of air into the lungs; the life of a fellow-creature being at stake, and dependent on the immediate and full establishment of artificial respiration, I felt that there was only one thing to be done—to empty the chest of the matters loading it, and that this must be done instantaneously. I accordingly applied my lips to the wound, and sucked out three or four mouthfuls of blood and mucus, when I had the satisfaction to see that air could be made to enter the lungs. After artificial respiration had been kept up for some time, the heart began feebly to act, the face became less livid, and the circulation was re-established; the patient did well, and was in good health many years afterwards.

Operations.—In opening the windpipe, the Surgeon has the choice of two situations in which he may make the aperture; either in the crico-thyroid membrane by **Laryngotomy,** or in some part of the trachea by **Tracheotomy.** Besides these two established operations, some Surgeons have performed a third—**Laryngo-tracheotomy**, by opening the crico-thyroid membrane, and dividing the cricoid cartilage with the upper rings of the trachea.

Whichever operation is performed, as soon as the windpipe is opened, the patient is seized with an attack of spasm and convulsive cough, often attended by much struggling and distress, during which the whistling occasioned by the passing of the air through the new passage is very loud and marked. The patient, however, soon recovers, and then breathes naturally and easily, the signs of asphyxia disappearing. In some cases the opposite condition is observed, the patient ceasing to breathe the moment the tube is inserted. This need cause no anxiety, as natural breathing speedily returns after a few movements of artificial respiration.

The windpipe may require to be opened either by laryngotomy or tracheotomy for the following conditions (L = Laryngotomy : T = Tracheotomy). The larynx of a child is too small to allow of laryngotomy being performed, and tracheotomy or laryngo-tracheotomy alone are possible.

1. Acute laryngitis with œdema of the glottis in the adult (L).
2. Chronic œdema of the glottis with suffocating spasms (L).
3. Syphilitic or other ulcerations of the glottis with chronic œdema (L).
4. Membranous laryngitis in children (T).
5. Membranous laryngitis in adults (L).
6. Necrosis of the cartilages of the larynx with obstructive thickening of tissues (T or L).
7. Epithelioma of the epiglottis and other growths obstructing the laryngeal orifice (L).
8. Tumours in the larynx (T).
9. Scald of glottis by boiling water or acids (T or L, according to age of patient).
10. Foreign bodies impacted in the larynx, in the adult (L), in the child (T).
11. Foreign body in the trachea or bronchus (T).
12. Impaction of foreign substances in the pharynx, in the adult (L), in children (T).
13. Asphyxia from any cause by which the glottis is mechanically closed (T or L, according to the age of the patient).
14. Accidents in operations about the head and face by which blood accumulates in the pharynx (L).
15. As a preliminary step in certain operations on the bones of the face, attended by much hæmorrhage (T).
16. Laryngeal spasm or paralysis from compression of the inferior laryngeal nerve by aortic aneurism (L).

Laryngotomy is an easy operation. The crico-thyroid membrane is almost subcutaneous, and may readily be reached by making a vertical incision in the mesial line, between the sterno-hyoids, about an inch in length, and then a cross cut through the membrane with an ordinary scalpel. The air-passage having thus been opened, a silver tube, curved on the flat, may be readily introduced and retained by tapes round the neck. The only troublesome result that can occur in this operation is the wound of a small artery, the crico-thyroid branch of the superior thyroid, which crosses the membrane. I have never seen any trouble arise from this ; but, should it occur, the hæmorrhage would readily be arrested by the application of pressure or ligature.

In cases of extreme urgency, it is recommended by some Surgeons that laryngotomy be performed by a transverse instead of by a longitudinal cut through the superficial structures in order to save time. In this opinion I do not agree ; little if any time is saved, and peril may ensue by cutting across the branches of the anterior jugular veins—thus leading, as I have seen, to profuse hæmorrhage, equally embarrassing and dangerous. There is, moreover, some risk of the formation of an aërial fistula. In all cases the longitudinal cut answers perfectly, and the crico-thyroid membrane can be opened by it in less than five seconds.

Tracheotomy consists in making an opening into some part of the trachea, by exposing the tube and cutting across two or three rings.

There are three situations in which the trachea may be opened; above, behind, and below the isthmus of the thyroid body, which usually crosses it opposite its second and third rings. Above the isthmus, the trachea is comparatively superficial, being covered merely by the skin and superficial fascia, the deep fascia, and the sterno-hyoid muscles. Beneath the muscles will be found a strong fascia, which comes downwards in front of the larynx from the hyoid bone and divides above the thyroid body, inclosing its isthmus between its two layers. This fascia is of some importance, as it is difficult to push the isthmus downwards so as to expose the upper rings of the trachea without notching this transversely. Below the thyroid gland the trachea recedes from the surface and is overlapped by the sterno-hyoid and sterno-thyroid muscles, beneath which is some loose areolar tissue in which lie the inferior thyroid plexus of veins, which are of large size, together with some tracheal branches from the inferior thyroid artery, and in rare cases an irregular arterial branch ascends from the aorta in front of the trachea to the thyroid body—the thyroidea ima. Beneath the deep fascia, but superficial to the muscles on each side, lie the anterior jugular veins. These are variable in size, become larger below, and sometimes communicate by a branch crossing the line of the tracheotomy wound. The carotid arteries also are in close relation to the trachea on each side, being more especially in danger at the lower part of the neck. Opposite the episternal notch, the windpipe is crossed by the left innominate vein, which has been seen by Macilwain lying high at the very point where tracheotomy is usually performed. A glance at these important relations will suffice to indicate the difficulty that must in many cases occur in exposing and opening the trachea. This difficulty is greatly increased when the veins of the neck have become turgid in consequence of the pulmonic obstruction. It will be seen also that the trachea is less covered, and may consequently be much more readily reached above, than below, the isthmus of the thyroid gland. Though some Surgeons, as Velpeau, for instance, have recommended the opening to be made in the lower part of the tube in all cases, no advantage whatever is gained by so doing, whilst the difficulties of the operation are very seriously increased; and in practice it is almost invariably opened at its upper part, usually through the first and second rings.

The patient should, if possible, be placed on a table in a good light. In operating on an adult, it will be found sufficient in most cases to support the patient's shoulders with pillows, while the head is thrown as much back as practicable. In children, a small firm pillow must be placed under the neck, so as to throw the trachea as much forwards as possible. A stocking stuffed tightly with towels will usually be found to answer the purpose admirably. An assistant should be seated above the head of the patient; it is his duty to hold the head steady with his wrists, while with a blunt hook in each hand he draws the wound open during the operation. At the same time he must keep the chin exactly in the middle line to serve as a guide to the Surgeon. The hooks must never be entrusted to two separate assistants, as they would certainly displace the wound from the middle line. If another assistant is present, he may give the anæsthetic and sponge the wound. The Surgeon stands to the right side of the patient. During the operation every vessel that bleeds must be immediately seized in forcipressure forceps which not only arrest the bleeding, but, if allowed to hang down on each side, help to hold the wound open.

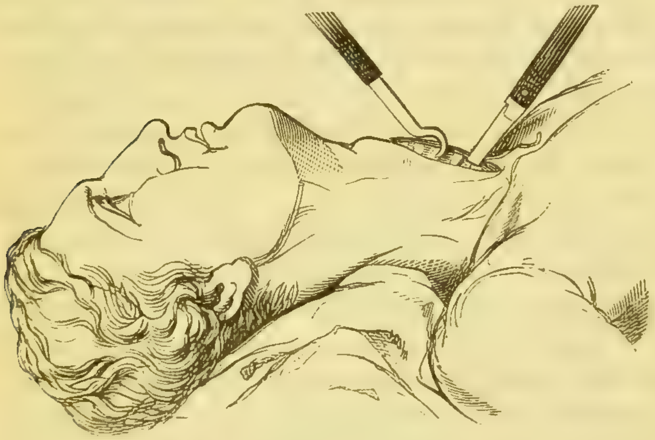


Fig. 771.—Operation of Tracheotomy.

If it be intended to open the trachea *above* the isthmus of the thyroid body, the incision must be commenced at the upper border of the cricoid cartilage and carried downwards directly in the middle line for an inch to an inch and a half, according to the age and size of the patient and the amount of subcutaneous fat. After dividing the integuments, the interval between the sterno-hyoid muscles must be found, and these drawn apart. Any veins that present themselves should be avoided as carefully as possible, and held on one side by the assistant, who has charge of the blunt hooks. After the muscles have been drawn apart, the isthmus of the thyroid body comes into view, and above it is the fascia that supports it and covers the trachea. The lower border of the cricoid cartilage should then be felt for; it can be recognized by its forming a slight projection above the level of the trachea, which can be readily felt with the finger-nail. If the parts are well in view, the trachea may be best exposed by the plan recommended by Bose. The layer of fascia in front of the trachea which supports the isthmus is picked up with a pair of forceps at the lower border of the cricoid cartilage, and carefully divided transversely for a distance sufficient to admit the handle of the scalpel beneath it, by means of which the isthmus is pushed downwards, and the upper three rings of the trachea clearly exposed. The trachea is then transfixed with a sharp hook and drawn forwards to steady it while the opening is made. It is usually recommended to insert the hook in the middle line, immediately below the cricoid cartilage, but the plan devised by J. Marshall will be found more convenient. In this, the hook is inserted about an eighth of an inch from the middle line parallel to the intended incision, its point being made to reappear so as to puncture the trachea in two places, and to get a firm hold on it. The opening in the trachea is then made, the knife being held by the blade about half an inch from its point, so that it is not possible to transfix the trachea and puncture the œsophagus. The incision must be made from below upwards, and should include two, or if necessary, three rings of the trachea. The tube may now be easily inserted by drawing one lip of the opening well forwards with the hook that has been inserted parallel to it, while the other is depressed with the end of the tube. If this be done, it slips in without any difficulty. It must then be retained by tapes round the neck.

If the trachea is to be opened *below* the isthmus of the thyroid body, the incision must commence immediately below the cricoid cartilage, and be carried downwards for at least an inch and a half. The muscles are exposed and separated as in the previous operation. In this situation the sterno-thyroids will probably come into view after the sterno-hyoids have been drawn aside. The isthmus, having been exposed, must be drawn upwards with a blunt hook. At this stage of the operation, the large veins forming the inferior thyroid plexus must be carefully avoided, and if the wound be very deep it is safer to use the scalpel to a limited extent, dilating the deeper parts of the wound with its handle or with a director. In young children the thymus gland will appear in the lower part of the incision, and require to be pushed downwards.

Opening the trachea *behind* the isthmus is seldom necessary, but should it be unavoidable the tissue of the thyroid body may be divided with but little bleeding if the knife be kept accurately to the middle line. *Laryngo-tracheotomy*, in which the cricoid cartilage is divided with one or two of the upper rings of the trachea, is occasionally performed intentionally, but more often accidentally, in young children, the cricoid being mistaken for a ring of the trachea. The accident, if such it can be called, is not productive of any injury to the patient.

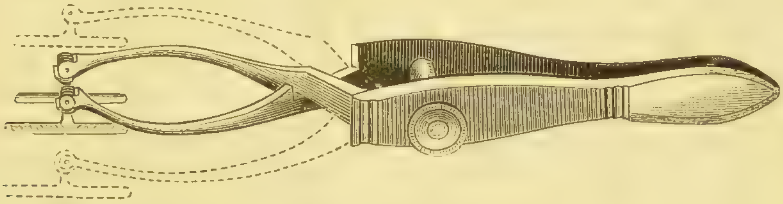


Fig. 772.—Automatic Retractor.

The question as to the **safety of the administration of chloroform** in these operations often occurs. I believe that it may always be given safely except in cases of extreme syncopal asphyxia, where, as sensibility no longer exists, it is unnecessary. Laryngeal inflammation and obstruction are always associated with so much spasm, more particularly in children, that it will often be found that the patient respires more easily and fully whilst under the influence of chloroform than before its inhalation was commenced; and, as the anæsthesia materially facilitates the operation by doing away with his writhings and strugglings, I invariably have recourse to it. In laryngotomy in the adult it does not appear to me to be necessary.

Difficulties and Accidents.—This operation is often attended by extreme difficulty, and not unfrequently by much danger.

The difficulties occurring in tracheotomy are chiefly referable to four heads: 1. Difficulty in Exposing the Trachea; 2. Profuse Hæmorrhage; 3. Difficulty in Opening the Trachea; and 4. Trouble in Introducing the Trachea-Tube.

1. The **Difficulty in Exposing the Trachea** increases greatly as the incisions approach the sternum, and is especially great in stout, short-necked persons. The want of an assistant to hold the wound open adds greatly to the difficulty of the operation. This may, however, be overcome by the use of the ingenious "Automatic Retractor" devised by R. W. Parker (Fig. 772). The forcipres-

sure forceps on the vessels will also help to hold the wound open. The accidents in this part of the operation arise very commonly from taking the guides incorrectly. In their anxiety to open the trachea above the thyroid body, young operators are apt to make the incisions too high. The pomum Adami of a young child, especially when covered by much fat, is scarcely to be felt, and the hyoid bone is sometimes mistaken for it. Owing to this error I have more than once seen the thyroid cartilage partly divided, and in one case an opening made even in the thyro-hyoid space. The mistake is avoided by taking the sternal notch as the guide, and making the incision in a child reach to about a finger's breadth above it. Insufficiency of the incision is a frequent source of difficulty. Even in the smallest children it should never be less than one inch in length. Deviation from the middle line is a common cause of accident, leading to wounds of the thyroid body or even of the carotid artery, or to great difficulty in finding the trachea. It may be the fault of the assistant, who should keep the chin exactly in the middle line as a guide to the Surgeon. In very young children an inexperienced assistant may even draw the trachea on one side with the blunt hook.

2. The **Hæmorrhage** may occur either from arteries, from veins, or from the thyroid gland. Arterial hæmorrhage is less frequent and troublesome than the bleeding from other sources. When it occurs, it happens chiefly from the wound of some anomalous branch, or from that of the small tracheal vessels. Desault has, however, mentioned a fatal case, in which death arose from a wound of the carotid. The arterial anastomosis of the isthmus of the thyroid body may, if this part be enlarged, occasion some difficulty in the performance of the operation; but the main source of danger is unquestionably the *venous bleeding*. Not only are the plexuses of veins of large size, more particularly where they cover the lower part of the trachea, but they become immensely gorged by the asphyxia that necessitates the operation. Hence, when they are wounded, the bleeding may be very abundant.

It is a generally recognized rule that all bleeding must be completely arrested before the windpipe is opened, lest the blood should enter the bronchi and asphyxiate the patient, or by lodging in the tubes and decomposing, should at a later period cause septic broncho-pneumonia. The only exception to this rule is when the case is urgent, and the bleeding does not proceed from any recognizable vessel, but is rather a uniform venous oozing due to the obstruction to the circulation through the lungs. In such cases the bleeding will continue so long as that obstruction remains unmoved. But as the respiratory process is re-established, the venous turgescence of the neck subsides, and the hæmorrhage proportionately lessens. This I have repeatedly found in asphyxia artificially induced in animals; and I have often seen it in the human subject, in cases in which it has become necessary to open the windpipe at once, without waiting to arrest hæmorrhage.

It is important to bear in mind that the risk of hæmorrhage is not entirely avoided by the use of blunt instruments. The veins are very thin-walled and easily torn, and I have seen very troublesome bleeding caused in this way by the incautious use of a director. The difficulties arising from hæmorrhage are very greatly increased by an insufficient incision. There is seldom any trouble in arresting the bleeding if the wounded vessel can be clearly seen. Sir Spencer Wells's forcipressure forceps will be found invaluable under these circumstances, as the vessel can be seized and the forceps left attached till the operation is completed. Should blood accidentally enter the trachea in such quantities as to threaten suffocation, it must be sucked out either by the mouth applied to the tube or by an aspirator tube passed down the trachea. As in diphtheria it is extremely dangerous for the operator to suck the tube, it is advisable, when performing tracheotomy, always to have an aspirator at hand in case of need. R. W. Parker has invented a simple apparatus by which suction can be performed without danger. It consists simply of a tube to pass down the trachea, and another with a glass mouth-piece, connected by an oval glass bulb, which is plugged with carbolized cotton-wool, which thoroughly filters any air passing through it.

3. Another difficulty in tracheotomy sometimes attends the process of **Opening the Trachea** after it is exposed. In consequence of the convulsive breathing of the patient, the sterno-mastoids are put upon the stretch, thus increasing considerably the depth of the wound in the neck; and, at each short and gasping respiration, the air-tube is rapidly jerked up and down, approaching to and receding from the surface in such a way that the scalpel cannot be thrust into it with safety. This difficulty is best avoided by thoroughly cleaning the trachea before attempting to open it, and then inserting the hook in the way already described, and drawing it well forwards. Edwards recommended that a sharp hook grooved on its convexity (Fig. 773) should be introduced under the cricoid cartilage, and the windpipe pulled up and opened by sliding the scalpel along the groove and cutting downwards. I have occasionally used the cutting hook (Fig. 774), and some Surgeons prefer, instead of the scalpel, to open the trachea with cutting forceps, or with a trochar carrying a cannula in the shape of a trachea-tube; but these instruments, though ingenious, are not so safe or easy of management as the scalpel and sharp hook.

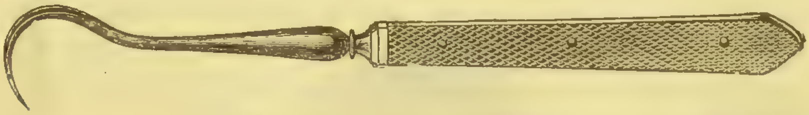


Fig. 773.—Trachea-hook-Director.

Fig. 774.—Cutting Trachea-hook.

An accident likely to happen at this stage of the operation is wound of the œsophagus. This is avoided by steadying the wrist on the sternum while making the incision, by drawing the trachea well forward with the sharp hook, and by holding the knife by the blade so that not more than half an inch projects beyond the finger and thumb. I have heard of a case in which, for want of these precautions, not only was the œsophagus wounded, but at the post-mortem examination the mark of the knife was found upon the bodies of three of the cervical vertebræ.

In rare cases the mucous membrane of the trachea has been pushed before the knife, but this is practically impossible if the hook be used as described on p. 722, and if the point of the knife be properly sharp. In cases of diphtheria in which the false membrane forms a distinct tube lining the trachea, it may be pushed before the point of the knife, and thus, if the tube be inserted at once, no air may enter. This accident is avoided by adopting the plan of holding the wound in the trachea open with a dilator, and removing all membrane that can be seen before introducing the tube.

4. After the trachea has been opened, the next point is to **Introduce a proper Tube.** In doing this, special care must be taken not to push the tube into a sort of pouch which always exists at the lower angle of the wound, between the trachea and the deep fascia of the neck. This error is not only embarrassing in the highest degree to the Surgeon, but dangeous to the patient by the delay it occasions, by the compression exercised on the trachea below the opening into it, and by the suction of blood into the aperture in the air-tube. It is best avoided by expanding the tracheal opening with the dilator (Fig. 777), and passing the tube between the blades of that instrument, or by adopting the method already described of inserting the sharp hook parallel to the line of incision instead of above it. In passing the tube into the trachea some difficulty may be experienced, owing to the elasticity of the sides of the incision in the windpipe, in consequence of which one of them is apt to be doubled in under the end of the instrument. This may be avoided by introducing the sharp hook in the manner described above, or by the use of Fuller's bivalve tube introduced closed (Fig. 775), and then expanded by slipping a cannula into it (Fig. 776). If the rings of the trachea be very rigid and unyielding, the silver tube may most conveniently be introduced by expanding the incision by means of the trachea-dilator (Fig. 777), and then passing it between or under their blades.

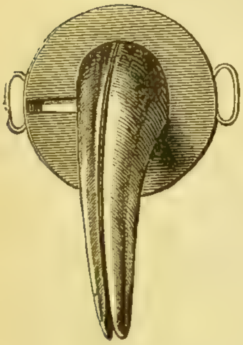


Fig. 775.—Bivalve Tube closed.

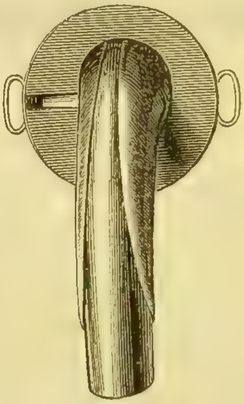


Fig. 776.—Bivalve Tube with Cannula introduced.

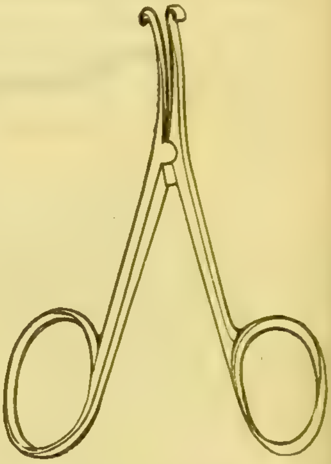


Fig. 777.—Trachea-dilator.

Trachea-tubes should be of such a calibre throughout as to admit of respiration being carried on through them, without any effort on the part of the patient. Many of those that are to be met with in the instrument-makers' shops, though very wide at the mouth, are far too narrow and contracted at the lower aperture to allow a free and unimpeded passage for the air of respiration, being made very conical in order to admit of easy introduction, and to occlude the opening in the windpipe completely, so as to prevent the entry of any blood by the side of the tube.

It is most important after the operation to keep the tube from being clogged by mucus. The frothy mucus which the patient constantly brings up after the operation is easily removed by wiping it away with a sponge during the expiratory efforts of coughing, and by the occasional introduction of a feather moistened with a solution of carbonate of soda. It will be found, however, that after a few hours the lumen of the tube becomes narrowed by an adherent layer of dried mucus on which the feather makes no impression. This accumulates in the largest quantity at the inferior aperture and at the curve of the tube, and may seriously block up its calibre while the external opening appears quite free. Obré devised a very simple means to remedy this inconvenience. It consists in the trachea-tube being made of uniform calibre throughout, and having an interior tube accurately fitted to it, and projecting about one-eighth of an inch beyond the lower extremity of the outer tube. It is in the projection of the internal tube beyond the lower end of the external one that the great utility of this contrivance consists. If the two tubes be of the same length, or still more, if the innermost tube be the shorter, a plug of mucus may be left at the end of the outer cannula, on the withdrawal of the inner tube. But if this be the longer of the two, the end of the outer tube will be effectually cleared every time it is withdrawn, which may be done as often as any mucus collects, without in the slightest degree disturbing the patient. The two tubes are fixed by means of a button, attached to the edge of the outer one (Figs. 778, 779). The bivalve trachea-tube (Figs. 775, 776) is constructed on the same principle, the inner tube being longer than the outer ; and it possesses the additional advantage of being readily removed for the purpose of cleaning, and as easily replaced. For laryngotomy, the tube is curved on the flat (Fig. 780) ; the longest diameter being lateral, thus being adapted to the form of the aperture in the crico-thyroid membrane.

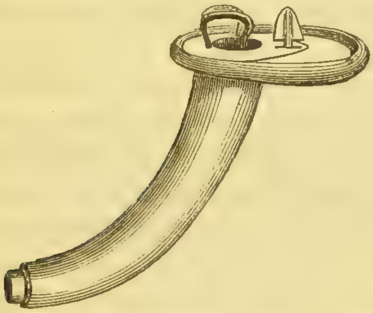


Fig. 778.—Trachea-tube, Side View.

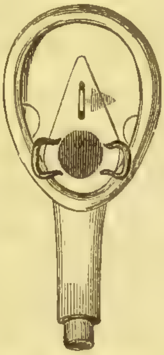


Fig. 779.—Trachea-tube, Front View.

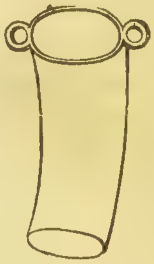


Fig. 780.—Laryngeal Tube.

It sometimes happens that, in consequence of the tube becoming detached from the shield, it slips into the trachea, where it acts as a foreign body. Cases of this kind have been related by Walters, and by J. W. Ogle. The removal of the tubes was effected by means of forceps. For the prevention of such an accident, it has been suggested that the trachea-tube should be formed in one piece, instead of in two pieces soldered together.

When a trachea-tube has been worn for any length of time, it will almost always be found that ulceration has taken place in the trachea at some point as the result of pressure. The discharge from this ulcerating surface, and the increased secretion caused by the accompanying irritation, add greatly to the difficulty experienced in keeping the tube from becoming choked. To overcome these difficulties, Morrant Baker has employed a tube made of india-rubber, such as is used in the manufacture of the india-rubber catheter. It has sufficient rigidity to prevent its collapsing, but not sufficient to give rise to irritation or to cause ulceration. It is to be introduced after the first twenty-four hours, a silver tube being used till then. The tube is single, but the ease with which it can be removed and re-introduced is so great, that there is no difficulty in keeping it clean ; in fact the irritation produced in so doing is said to be less than that caused by the removal of the inner tube of any ordinary double trachea-tube. Baker has found, from experience in a considerable number of cases, that it is worn with much greater comfort to the patient than a rigid tube.

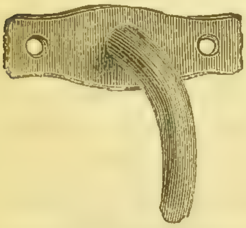


Fig. 781.—Baker's Tracheotomy-tube.

R. W. Parker has pointed out that the ulceration caused by the point of the cannula is in great measure due to the fact that the ordinary quarter-circle tubes do not correspond with the natural direction of the trachea ; he has therefore devised an angular tube to overcome this difficulty. It is fitted with the movable collar invented by Roger of Paris, which will be found to be more comfortable to the patient than a rigid shield.

Tracheotomy in Children is never easy, and is at times a dangerous operation. The difficulty of the operation arises more particularly in infants and very young children from the shortness of the neck, and the depth and small size of the trachea. Before the age of puberty, this tube is usually thickly covered by a quantity of loose granular fat, containing many veins, and is of small size, so that a slight deviation of the incision to one side may readily lead the Surgeon astray, and into dangerous proximity with the carotid arteries. The danger of the operation results from the large size of the venous plexuses in connection with the thyroid body. In performing this operation in young subjects, chloroform should always be administered. This may be done with safety, even though the most urgent dyspnœa be present ; the difficulty of respiration, being in a great measure spasmodic, is relieved by the anæsthetic. If chloroform be not given, the struggles of the child will seriously embarrass the operator. The dangers and difficulties of the operation are avoided only by attention to the advice already given, to keep accurately to the middle line, to avoid operating too high, mistaking the hyoid bone for the pomum Adami, to make a sufficiently free incision, and above all to avoid needless hurry in cases in which asphyxia is not imminent, and to do the operation by a careful process of dissection, rather than by irregular tearing with blunt instruments.

Comparison of Tracheotomy and Laryngotomy.—On comparing tracheotomy, as ordinarily performed, with laryngotomy, I think there can be little doubt that the Surgeon should give the preference, in all cases where it is practicable, to the latter operation, on account of its greater simplicity, safety, and rapidity. When the windpipe is to be opened for the extraction of a foreign body, tracheotomy should be performed in preference to laryngotomy, as the latter operation does not provide a sufficient opening for its expulsion or extraction. In children the larynx is so little developed, that tracheotomy must always be done. In all cases in which the obstruction to respiration is produced by inflammatory effusion into the submucous areolar tissue, or œdema glottidis, whether dependent upon idiopathic or erysipelatous laryngitis, or chronic disease of the larynx, or upon the irritation and inflammation excited by swallowing boiling water or the stronger acids, in my opinion, laryngotomy is the operation that should be preferred in the adult; and this opinion is based on the following reasons.

1. As in laryngotomy the air-tube is always opened below the seat of obstruction, there can be no necessity to make an aperture farther from the seat of disease. In laryngitis, whether acute or chronic, the obstruction to breathing depends upon swelling of the lips of the glottis causing an impediment to the entrance of air. But this loose submucous areolar tissue terminates at the true vocal cords, where the mucous membrane becomes directly applied to the subjacent fibrous structures; the swelling and consequent mechanical impediment are hence confined to the limits of the thyroid cartilage, and any opening made below this will clear the lowest limit of the disease, which is always accurately bounded below by the vocal cords. Hence an aperture in the crico-thyroid membrane is quite as effectual as one in the trachea.

2. Laryngotomy is a far safer operation than tracheotomy. On this point I need scarcely dwell; a glance at the anatomy of the parts concerned will be sufficient to establish it. The crico-thyroid membrane is nearly subcutaneous, and no parts of importance can be wounded in opening it, if we except the small crico-thyroid artery which crosses it, and which might be cut across, but from which I have never seen any trouble arise. The trachea, on the contrary, is not only deeply seated, but covered by a large plexus of blood-vessels, which, when rendered turgid by the asphyxiated condition that exists when an operation is required, pours out a large quantity of dark blood, and thus seriously embarrasses and delays the Surgeon at a time when the life of the patient depends on the speedy admission of air to his lungs.

3. Laryngotomy can be much more quickly performed than tracheotomy. This I look upon as an inestimable advantage in many of the cases requiring operation; a few seconds more or less being sufficient to turn the balance either in favour of life or of death. The rapidity with which laryngeal obstruction—partly mechanical and partly from spasm—sets in, is sometimes so great, more particularly when an acute inflammation supervenes on chronic disease of the larynx, that life may be extinguished before the Surgeon has time to open the windpipe, if he endeavour to do so by tracheotomy. In extreme cases, in which the lungs have become slowly engorged, the action of the heart is already enfeebled, and a sudden spasm occurring at the glottis, will at once place the patient beyond recovery. But even though life appear for the moment extinct, it is the imperative duty of the Surgeon to open the air-passage as speedily as possible, and to endeavour, by means of artificial respiration, to recall the flickering spark; and it is impossible to experience a greater satisfaction in the exercise of our profession, or to witness a greater triumph of art, than in thus snatching a patient out of the very jaws of death.

An objection has been urged to laryngotomy in these cases, that it does not allow the patient to wear a tube without much irritation being induced. This, however, I have not found to be the case in my practice. I have had patients who have worn silver tubes in this situation a considerable number of years, in one case as many as twelve, and in whom no special irritation has been occasioned by them.

After-Treatment of Laryngotomy and Tracheotomy.—In all cases after the windpipe has been opened, the patient should be placed in a well-warmed room, the air of which should be kept moist by means of steam. A thin piece of muslin folded two or three times may be laid over the opening of the tube to exclude dust. If the operation have been performed for some temporary obstruction of the glottis, such as the impaction of a foreign body, the tube may be taken out as soon as the cause is removed, and the wound allowed to heal by granulation, or as suggested by Sir W. MacCormac, the wound in the trachea may be closed by cat-gut sutures.

The *after-treatment of tracheotomy for membranous laryngitis* requires special attention, as the success of the operation depends almost entirely upon it. The objects in view are, 1st, to provide a warm moist atmosphere, in order to diminish as far as possible the risk of bronchitis ; 2nd, to keep the tube clean and free ; 3rd, to hasten the separation of the membrane and limit its extension ; and 4th, to remove the tube at the earliest possible period.

A *warm moist atmosphere* is best provided by placing the child in a bed over which a sort of tent of sheets is reared, supported by pieces of lath or iron attached to the legs of the bedstead. One side of this tent must be left open, and through this opening a current of steam must be introduced from a kettle, to the nozzle of which a tin tube is attached. The best apparatus for this purpose is the "croup kettle," invented by R. W. Parker, which supplies a current of warm air mixed with the steam, thus efficiently maintaining ventilation as well as warmth and moisture. By its means the temperature can be easily regulated, so that there is little risk of weakening the child by over-heating. 2. *The tube must be kept clean* by frequently removing the inner part and washing it with warm water and cleaning the inside with a feather. If it is caked inside with dried mucus this will be readily removed by a solution of carbonate of soda. After the fourth day the outer tube also may be removed and cleaned once every twenty-four hours. The patient must be constantly watched day and night, and any mucus that appears at the orifice of the tube during efforts at coughing must be wiped away with a sponge. 3. To *hasten the separation of the membrane and to prevent its extension* various substances may be administered by inhalation. Acting on the theory that the formation of the membrane is dependent on the micrococci which are invariably found in it, quinine, carbolic acid, creasote and eucalyptus inhalations have been recommended. Carbolic acid, creasote and eucalyptus oil may be administered by adding a few drops to the water in the kettle, from which the steam is being supplied. Quinine may be given by means of a spray from a Siegel's apparatus, the solution used containing about four grains to the ounce. Solvents may be used in the same way to soften the membrane ; the best of these is carbonate of soda (gr. xx. to ℥j.). Lactic acid also has been recommended, but it does not seem to be superior to the soda solution. These substances in spray may be used every two or three hours, the child being wrapped in a mackintosh cloth at the time to avoid wetting the clothes. R. W. Parker, believing that in all cases of membranous laryngitis the disease is at first local, and that the general symptoms are due to the absorption of the unhealthy products of the local process, insists very strongly on the necessity of clearing these away both at the time of the operation and afterwards. Before inserting the tube he recommends that the incision in the trachea should be held open with hooks or a dilator, while all membrane within reach is removed by means of a feather, which has been previously soaked in a solution of carbonate of soda. In order to clear the larynx the feather may be passed upwards into the mouth. This apparently severe treatment has in his hands proved very successful, no fewer than 8 out of 16 cases thus treated having recovered.

The feeding of the patient must not be neglected, even if considerable persuasion be necessary to make the child swallow. Food should be given about every two hours, and soft solids will often be taken more easily than liquids.

4. The *removal of the tube* should always be accomplished as soon as possible. It is often difficult to determine when this can be safely done. Many tubes are made with an opening at the upper part, so that the patency of the glottis can be ascertained by placing the finger over the external opening, and observing the effect. The return of the voice, more or less perfectly, when the opening is closed, is usually a sign that the tube may be safely removed. In rare cases there is much delay in getting rid of the tube owing to persistence of the laryngeal obstruction. Cases of this kind may be divided into two classes; those in which the obstruction is due to spasm or paralysis of the larynx and those in which there is actual mechanical obstruction. It sometimes happens that the passage of air through the larynx, after a tube has been worn for some time, causes a spasm of the glottis, which may threaten suffocation. This is best overcome by removing the tube periodically for longer or shorter intervals until the patient becomes accustomed to its absence. Or a tube with an opening in its upper part may be used, and the external opening may be plugged with a cork which can be at once removed should dyspnœa occur. Paralysis of the abductor muscles has been recorded by Gerhardt, but it is exceedingly rare and its cause is very uncertain. *Mechanical obstruction* after tracheotomy may arise from three causes; obstruction by masses of fungating granulation-tissue, adhesion of the vocal cords, and cicatricial contraction of the glottis, consequent upon the disease for which the operation was performed. The formation of fungating granulation-tissue may occur above the tube, projecting upwards into the larynx, or more rarely below the tube where its point touches the trachea. R. W. Parker has recorded a fatal case of obstruction of the tube by a mass of granulation-tissue formed below it. More commonly the granulation-tissue is above the tube and prevents its removal. The treatment in these cases consists in the application of nitrate of silver, either by means of a coated probe or a brush dipped in a solution of 30 grains to one ounce of water, introduced by the wound. If this fails, a tracheal catheter may be passed through the larynx, and retained for from twenty-four to thirty-six hours if possible. The pressure and the mechanical effects of the passage of the catheter may destroy the fungating mass. If this fails the parts may be carefully scraped with a sharp spoon, the head being allowed to fall backwards so that blood shall not flow down into the lungs. The passage of a feather upwards may be sufficient to clear the passage. Chloroform is, of course, required for any of these proceedings. Adhesion of the vocal cords is rare, and is treated by the passage of an instrument upwards from the wound. Cicatricial contraction commonly occurs in cases of syphilitic disease, and little can be done to remedy it.

SURGICAL OPERATIONS ON THE CHEST.

Tapping the Pleural Cavity.—The operation of **Tapping the Pleural Cavity** is required in cases of hydrothorax, empyema, and hæmothorax. The point of selection is a spot in the fifth intercostal space on the lateral median line. This point is crossed by a line drawn horizontally round the body from the nipple to the spine.

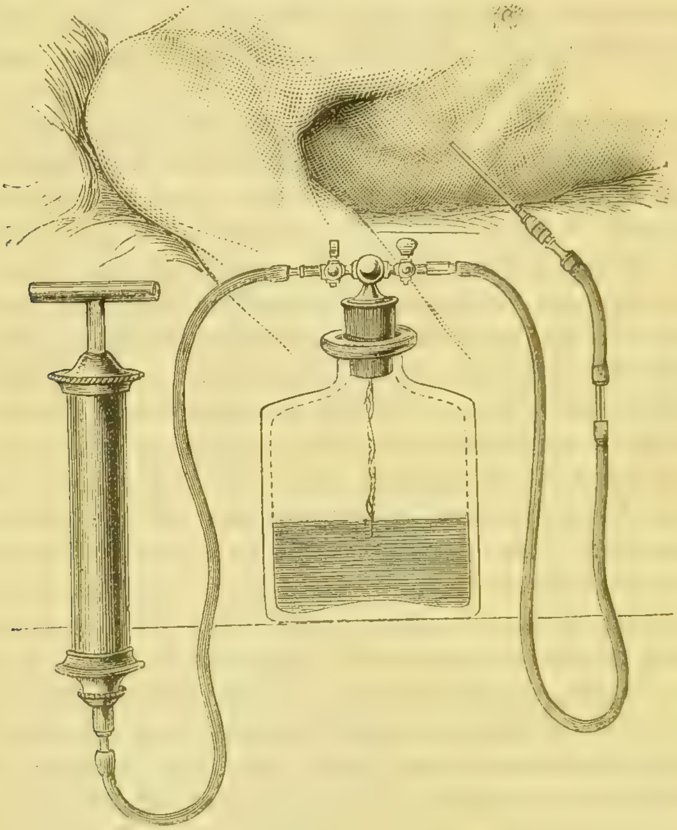


Fig. 782.—Tapping the Chest by the Bottle-Aspirator.

As it is of great importance in cases of *hydrothorax* to exclude the air from the pleural sac, the operation is now almost invariably performed by the aspirator. The original aspirator, as invented by Dieulafoy, slightly modified (Fig. 94, Vol. I., p. 246), will be found the most convenient instrument, as it can be converted into a syphon at will. The ordinary bottle-aspirator (Fig. 782) will, however, usually answer the purpose well enough. The air having been exhausted from the bottle by means of the air-pump, and the stop-

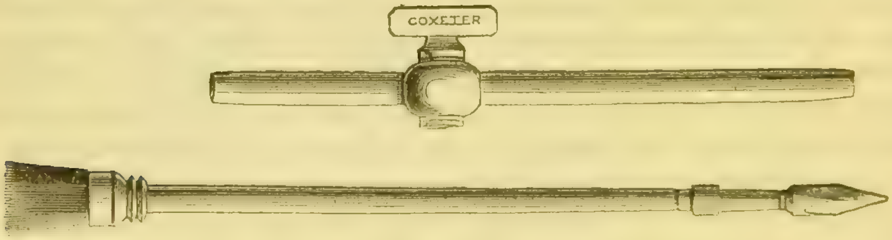


Fig. 783.—Piston-Trochar for Tapping the Chest.

cock closed, the chest is tapped in the way to be presently described with the aspirator-trochar; and the cock in its side being turned on, the fluid rushes into the exhausted bottle to fill up the vacuum.

Other instruments also have been designed for the purpose of preventing the entrance of air during the operation. Of these the two most efficient are the "*piston-trochar*" (Fig. 783), or Thompson's "*syphon-trochar*" (Fig. 784).

If the "piston-trochar" (Fig. 783) be used the tap should be closed as the stylet is withdrawn, and an india-rubber tube attached to the end of the cannula. The tap being then opened, the fluid flows along this into a vessel containing a 1 in 20 solution of carbolic acid. If the syphon-trochar be used the fluid is allowed to run off by the elastic tube, the end being in the same way immersed in an antiseptic solution.

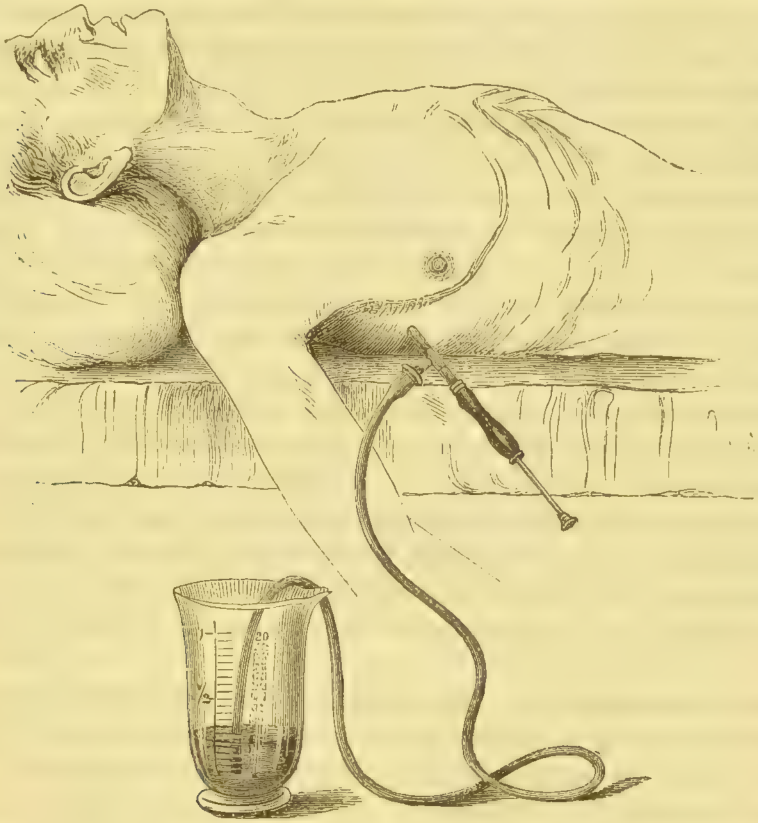


Fig. 784.—Tapping the Chest by the Syphon-Trochar.

In the absence of all special instruments the chest may be safely tapped with a common trochar by the simple method suggested by Reybard. A piece of thick linen or cotton rag free from holes is made into a funnel, the narrow end of which is tied lightly round the cannula immediately below its expanded end. The funnel is then thoroughly soaked in carbolic oil (1 in 10). When the trochar is withdrawn the funnel of oiled rag hangs down from the end of the cannula, and serves to direct the fluid into a vessel held to receive it, and at the same time it forms an efficient valve which prevents the entrance of air during inspiration.

Whatever plan be adopted, the side of the chest, the operator's hands and all instruments used must be carefully washed in a solution of carbolic acid (1 in 20). The *lower* border of the sixth rib is then felt for, and if a trochar is being used, a small incision may be made through the skin, parallel to it, in the mid-axillary line. The point chosen should correspond to the interval between two digitations of the serratus magnus. If the aspirator is being used no incision is required. The skin is then drawn upwards till the point chosen in the skin corresponds to the *upper* border of the rib, and the point of the trochar is then slipped over its margin and thrust sharply and firmly into the pleural sac, so as to make sure of penetrating the thickened pleura, and any layer of false membrane, which if the instrument were pushed slowly on, might be thrust before it. By thus passing the trochar immediately above the rib any risk of wounding the intercostal artery or nerve is avoided, while by drawing up the skin before so doing the superficial opening and that in the intercostal muscles and pleura do not correspond and thus the track of the trochar is efficiently closed. After the withdrawal of the cannula the puncture is covered with some dry cotton-wool and collodion, or by a piece of adhesive plaster, and will usually unite without trouble. After tapping, the lung will expand and fill up the cavity previously occupied by the fluid.

If the aspirator is used the details described in Vol. I., p. 245, must be attended to. It must be remembered that when the vacuum is moderately perfect the lung is being expanded by the pressure of the atmosphere with a force equal to fifteen pounds to the square inch. This may possibly cause some injury by rupture of adhesions, and even cause hæmorrhage from the lung. If therefore the patient complains of severe pain after a certain amount of fluid has been withdrawn the operation must be at once brought to an end, and repeated after an interval of a day or two, if necessary.

The importance of antiseptic precautions such as have been described above even in a simple case of hydrothorax is very great. If they are rigidly carried out, tapping may be repeated several times without evil result, but should they be neglected the hydrothorax is very prone to become converted into empyema.

Surgical Treatment of Empyema.—When the fluid in the chest is purulent it is generally acknowledged that the patient's chance of recovery is but small, except by surgical interference. The consideration of general symptoms indicating the presence of pus in the pleura belongs to medicine rather than to surgery, and need not be discussed here. In all cases of doubt the diagnosis may be readily made by means of the aspirator. The presence of pus having been determined, there should be no delay in removing it. The longer it is left, the more firmly the lung becomes bound down by adhesions, and the probability of its perfect expansion becomes less. Moreover, the pus may burrow beyond the limits of the pleural cavity, finding its way downwards into the iliac fossa, or more rarely into the abdominal cavity, and thus add greatly to the gravity of the case. In a certain proportion of cases empyema may be cured by simple aspiration. It is advisable therefore always to attempt this before proceeding to the operation of opening the pleura by an external incision. If after withdrawing the fluid, the temperature falls, the general symptoms improve, and the fluid re-accumulates slowly, aspiration may be repeated with some hope of success. If, however, the relief is very slight and temporary, it is wiser at once to open the pleura and drain the cavity.

The operation of opening the pleura for empyema, though one of the most ancient in surgery, was until recently so unsatisfactory in its results that it was resorted to only in the last extremity. The fatal result that so frequently followed was due to septic fever and prolonged suppuration consequent upon imperfect drainage and decomposition of the retained fluid. With the view of preventing the accumulation of pus and diminishing the risk of septic poisoning Goodfellow and De Morgan adopted the use of Chassaignac's drainage-tubes with considerable advantage; but it was not until the introduction of efficient antiseptic treatment that the operation became really safe and successful. In discussing the operation the following points have to be considered :—1. The best point for making the opening; 2. The method of making it; 3. The form of tube; 4. The dressing and after-treatment; 5. The removal of the tube; 6. The results; and 7. The subsequent treatment of the cavity should the lung fail to expand.

1. **The best point for the opening** is the subject of considerable difference of opinion. Many Surgeons, following the ordinary rule of opening an abscess at its most dependent part, make the incision as far back and as low down as possible, the point chosen being either immediately below or a little in front of the angle of the scapula, in the seventh, or even as low as the ninth intercostal space. The advantages of this situation are however very doubtful.

The patient suffering from empyema usually does not lie flat upon his back but inclined towards the affected side so as to allow the freest possible play for the sound lung. An opening in the mid-axillary line will therefore be more dependent while the patient is confined to bed, and at least equally so when he is in the erect position. Moreover, the ribs posteriorly lie close together, making it difficult to insert the tube, and are thickly covered with muscles, necessitating a longer incision and more discomfort to the patient after the operation. Another and a more serious objection is that as the lung expands it first comes in contact with the chest walls posteriorly, the two pleural surfaces meeting last in front of the mid-axillary line. An opening made too far back is liable to become early overlapped by the expanding lung, and drainage is thus seriously interfered with, or a sinus difficult to heal may be left running forwards towards the anterior part of the chest. In cases in which the expansion of the lung is imperfect the diaphragm may rise up and obstruct the opening if it be made too low.

John Marshall has pointed out that immediately outside and below the junction of the fifth rib with its cartilage, is a point in the chest wall at which, from the comparative absence of superjacent muscles, the pleura is but slightly supported externally, and through this he believes an empyema tends naturally to point. This point is above the origin of the external oblique, external to the insertion of the rectus and internal to the origin of the serratus magnus. It is covered by the outer edge of the pectoralis major, and is beyond the anterior limit of the external intercostal muscle. That an empyema may perforate the chest at this spot is undoubted, but according to most authorities it tends to point higher up in the second or third space. Marshall, arguing from the excellent results that usually follow the opening of an empyema pointing in front, suggests that the opening should always be made on the thin point above mentioned. The only objection to this is that the ribs are somewhat closer together here than they are a little further back. The facts adduced by Marshall may however be said to demonstrate that openings made far back and low down do not present the advantages usually assigned to them, and that better results will probably be attained by making the incision more nearly over that part of the cavity which is the last to be closed by the expansion of the lung. The space between the fifth and sixth ribs, an inch to an inch and a half in front of the mid-axillary line, will probably be found the best in most cases. The interval between the ribs is wide enough here to admit a large tube readily, the covering of soft parts is not too thick, and the drainage obtained is efficient, and there is little risk of the opening becoming obstructed either by the expanding lung or the diaphragm. In cases of localized empyema the incision must, of course, be made over the collection of pus.

2. **The method of operating.** The operation should be performed with the strictest antiseptic precautions, including, if possible, the carbolic spray, which adds greatly to the certainty of preventing putrefaction, as it is almost impossible to prevent the entrance of air during inspiration. If the opening is made in the fifth space it is not necessary in ordinary cases to remove a portion of a rib. The incision should be made about an inch and a half in length parallel to the upper border of the sixth rib, exposing it clearly. Any superficial vessel that bleeds may then be secured. The intercostal muscles and pleura are then punctured with the scalpel, guided by the left fore-finger in the wound, immediately above the rib, so as to avoid the intercostal artery. The blade of the knife must be parallel to the rib. A pair of dressing-forceps may then be introduced and the wound stretched by expanding the blades, after which the tube may be at once inserted.

If the opening is made further back, or if, from partial absorption of the fluid part of the pus, the ribs have fallen together so as to leave an insufficient space for the introduction of the tube, a piece of the rib must be removed. Some Surgeons prefer always to remove a portion of rib, asserting that by this means a better opening is provided, but in the majority of cases it does not seem to be necessary. Should it be required the operation is thus performed. An incision from two to three inches in length is made directly upon the rib, the periosteum of which must be divided in the long axis of the bone. The wound is then held widely open with the blunt hooks and the periosteum stripped from the exposed part of the rib with an elevator, which must not be too sharp. No difficulty will be found in turning the intercostal artery out of its groove at the lower border. A curved elevator or a broad flat director is then passed completely under the rib from below upwards and the bone divided in two places with a saw or properly constructed bone-forceps, and about one inch of its length removed. The pleura should not be wounded up to this stage in the operation. All bleeding having been arrested, the pleura may be opened and the tube inserted. If it be preferred the operation may be performed by a T-shaped incision, but this usually presents no advantage over the simple longitudinal. The removal of a piece of rib is not accompanied by any difficulty or danger. Necrosis rarely follows, not more often apparently than after the simple insertion of a tube between the ribs. New bone rapidly forms from the periosteum, and after a time the continuity of the rib is restored, and sometimes a mass of bone fills the intercostal spaces. The operation may therefore be undertaken without hesitation whenever it seems to offer the slightest advantage.

3. The **Tube.** The ordinary india-rubber drainage-tube should be used, but care must be taken that there is no hole in the part corresponding to the chest walls, as granulations are apt to sprout up into it and obstruct the lumen. It must be provided with a shield, lest it slip into the pleural cavity. The best

form is that suggested by E. B. Baxter. It is thus prepared. In the middle piece of sheet india-rubber, about a sixteenth of an inch thick, and one inch and a half to two inches square, a round hole is cut of the same size as the drainage-tube. The tube is then passed through for a sufficient distance, and split into four pieces sufficiently long to reach to the four corners of the shield, to which they are attached by silver wire. The remainder of the tube on the other side of the shield must have holes cut in it at intervals, as in an ordinary drainage-tube. The tube must vary in diameter with the size of the patient. It should always be as large as can conveniently be passed between the ribs, but as the discharge lessens, a smaller size may be substituted. It need never be more than two or three inches in length. Nothing is gained by putting eight or nine inches of tube into the pleura ; it cannot suck the fluid out, and only causes needless irritation.

4. The **dressing and after-treatment.** The most efficient dressing is carbolic gauze. Should it cause irritation, eucalyptus gauze may be substituted for it. Should this not be at hand, an efficient absorbent dressing may be made of salicylic or iodoform-wool, sal alembroth gauze or wool, sublimate wood-wool, carded oakum or carbolized jute, covered with a piece of oiled silk or some other impermeable material to prevent the discharge from soaking through too soon opposite the wound. The dressing should be conducted under the carbolic spray, but if this cannot be done, the entrance of impure air can be prevented with a little care, by covering the opening immediately with a piece of rag soaked in some antiseptic solution as the dressing is removed, and drawing it out again from under the fresh dressing as it is applied. For the first few days daily dressings are required, but the intervals may be gradually increased. It is seldom advisable to leave it for more than a week, even if no discharge appears at the edge. In ordinary cases nothing is gained by washing out the cavity with antiseptic solutions, a proceeding which has been known to cause sudden death in more than one case, an accident the cause of which is quite unknown.

5. The **removal of the tube.** The time at which the tube should be removed is often a difficult point to determine. When the discharge becomes purely serous and very small in amount, the tube may at first be shortened till it is just long enough to retain its position. It is then often forced out by the granulations, or by the expanding lung. It is well to examine the cavity carefully with a probe before removing the tube, as the space unclosed may be larger than would be supposed from the amount of discharge. So long as a distinct cavity remains the tube should be retained. In children, especially if the opening has not been deferred too long, the wound may often be allowed to close after about a month. In adults, in whom expansion of the lung is often less perfect, and whose chest-walls are too rigid to sink in, many months usually elapse before the cavity is closed, and in some cases complete recovery never takes place. Long sinuses, very troublesome to heal, are occasionally left. These commonly arise from opening too far back or too low down, or from the prolonged retention of tubes of needless length.

6. The **results** of the operation for empyema are usually as satisfactory now as they were formerly unsatisfactory. In children, especially if the health is otherwise good, recovery is the rule. The temperature falls immediately after the operation, and unless some complication occurs, seldom rises again. If the operation be not too long delayed, complete expansion of the lung usually

takes place. This is effected by the gradual adhesion of the two pleural surfaces to each other, commencing in the angle of reflexion from the chest walls to the lung.

Operation *for empyema without antiseptic precautions* may occasionally be necessary when the means of proper treatment are not obtainable. The Surgeon must then rely on freedom of drainage, by which it may be possible so far to reduce the quantity of decomposable matter in the chest, that the dose of septic products absorbed by the patient shall not be sufficient to cause serious constitutional disturbance. This object is best attained either by making a free incision some inches in length between two ribs, or by the insertion of two tubes, one in the ordinary situation, and one at the lowest possible point in the pleura. The second opening may be made upon a curved probe passed in at the upper wound.

7. **Estlander's Operation.**—In cases in which the cavity continues to discharge after many months, or even years, showing no signs of diminishing either by contraction of the chest-walls or expansion of the lung, the patient's condition becomes very serious. If the cavity be very small it is possible the sinus may remain discharging a small quantity of pus without causing much inconvenience, but if it be of any size it is almost impossible to keep it clean, and the health is gradually impaired by the constant absorption of small quantities of septic matter, and finally death will almost inevitably occur from albuminoid degeneration of the viscera. In such cases Estlander proposed the removal of the bony wall of the chest corresponding to the cavity, so that the soft parts of the chest-wall should come in direct contact with the surface of the lung. This operation has now been performed in a large number of cases with a very considerable degree of success. The area of the cavity must first be accurately ascertained by careful probing. The ribs are then exposed by a free incision. This may be done by raising a large flap, or by a single vertical incision. In whichever way it is done the whole area from which the ribs are to be removed must be fully exposed, so that the thickened pleura can be cut away as well as the bones, and any bleeding vessel easily secured. The ribs having been exposed are removed separately for the required extent by the method already described. The thickened pleura with the periosteum which has been stripped from the ribs is then cut away with a strong pair of scissors. The intercostal vessels lying in this dense tissue are usually obliterated, so that there is singularly little bleeding. Unless the thickened pleura be removed as well as the ribs, the operation is certain to fail, as it is almost as unyielding as the bony wall. The wound is then cleaned with some efficient antiseptic solution and closed by sutures, a drainage-tube being inserted at the most dependent part, and an antiseptic dressing applied.

Estlander's operation is only applicable to cases in which the patient is otherwise in good health and free from tubercular disease of the lungs. It can scarcely ever be required except in adults, as the soft walls of a child's thorax readily fall in, even if the lung fails to expand.

TAPPING PULMONARY CAVITIES.

The operation of tapping vomicæ in the lungs in phthisical patients could not be done with certainty until the existence and precise seat of such cavities could be accurately determined by auscultation; for, prior to Laennec's time, the physician could not diagnose a pulmonary cavity from a circumscribed empyema communicating with the lung. Hence the accounts of such an operation given by the older writers on medicine from the days of Hippocrates down to the present century must be received with scepticism. But that the idea had suggested itself at an early period to medical practitioners of treating pulmonary cavities by incision or tapping, there can be no doubt; for, without going back to the earlier medical writers, we find Dr. Barry in 1726 recommending that phthisical cavities should be opened, with the view of giving a direct exit to the contained matters, and thus, by avoiding violent paroxysms of cough, that the parts may be kept at rest, and be more likely to undergo a cure. The proposal received little attention, and the practice—if ever adopted by others than Barry—died out, until, in 1836, it was revived by an empiric of the name of Ramadge, who appears to have tapped the chest on several occasions in order to let out pus from cavities in the lungs. In 1845 a most able young Surgeon—Storks—performed this operation with success, and with advantage to the patient, in a case under the care of Dr. Hastings. Storks operated by making a long incision upon the upper border of a rib, and then opening up the cavity by means of a pair of forceps, inserting a cannula to allow of the escape of the contents. This case attracted little attention at the time, and the operation again died out. Of late years, however, it has been revived, and Mosler of Greifswald has been more especially active in its resuscitation. Mosler not only tapped, but injected the cavities with disinfectant solutions.

In a case of Dr. Theodore Williams I operated by Storks' method. The patient, a gentleman 21 years of age, had an enormous cavity at the base of the left lung. The discharge from this was not only profuse, but most horribly offensive; the patient being unable, even by the most violent and continued paroxysms of cough, to empty the cavity, a large quantity of decomposed muco-pus was always present in it. I made an incision on the upper border of the seventh rib in the lateral mesial line, and pushing a large trochar and cannula through the sixth intercostal space, perforated with difficulty some very condensed tissue, probably thickened pleura and fibrosed lung, and then penetrated the cavity. Nearly two pints of muco-pus were discharged, and the patient derived great relief; the cough diminished, and then entirely disappeared. The cavity was washed out with dilute Condy's fluid. Immediately on the cavity being opened, extensive subcutaneous emphysema occurred, but gave rise to no trouble of any moment. The patient was greatly benefited by the operation, and lived for six months after in comparative comfort.

Dr. Pepper of Philadelphia, who has published an exhaustive article on this subject, adopts a different procedure. He taps the vomica with a small cannula and trochar fitted to a syringe, and injects the cavity with diluted tincture of iodine. Shingleton Smith instead of iodine has used a solution of one grain of iodoform in five minims of ether injected by means of a Pravaz's syringe. Although in some cases the fœtor of the expectoration was diminished but little curative result was obtained.

During the last few years cavities of the lung of various kinds have been opened by Marshall, Godlee, Gould, and others, but the limits of the operation and the best cases for its performance have yet to be determined. The state of opinion at the present time is thus summed up by Godlee: 1. Gangrenous cavities should always be sought, and, if possible, opened, and the prognosis, if the operation be successful, is not bad. 2. The same may be said in regard to abscesses caused by rupture of purulent collections from other parts into the lung, at least as regards the pulmonary complication. 3. Abscesses connected with foreign bodies must be opened, and, if the body be not found, it must be remembered that if of any size, it probably lies pretty near the middle line. 4. Bronchiectasic cavities when single (a very rare condition) will be cured by operation. When multiple (a very common condition), they offer but small chance of relief. 5. Tubercular cavities should only be opened when the cough is harassing and the cavity single. Injections may be used to relieve symptoms, but cannot be expected to cure.

Operation.—The operation may be done by means of a cannula and trochar, or the surface of the lung may be fully exposed by removal of a rib, and the incision made with a bistoury, and followed by insertion of the finger if desirable. The latter plan is recommended in most cases by Godlee. In either method the existence and situation of the cavity should be proved by means of the aspirator before more serious measures are undertaken.

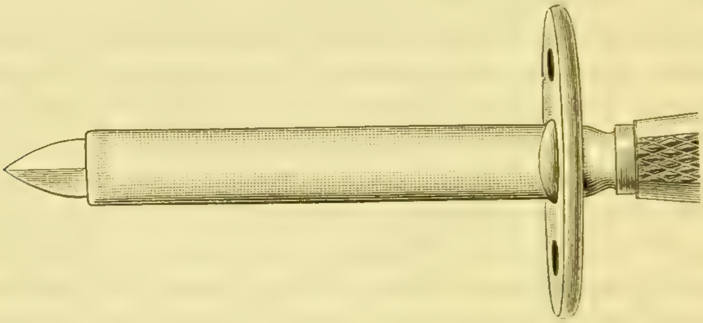


Fig. 785.—Trochar for Tapping Pulmonary Cavities.

The operation with the trochar is thus performed. An aspirator-needle of sufficient size to permit the passage of thick pus, having been thrust through the intercostal space, opposite to the seat of the supposed abscess, will, if it penetrate the cavity, indicate by the escape of pus that this has been reached. A horizontal incision about two inches long is then made in the intercostal space. A full-sized flat trochar (Fig. 785) is then thrust through the pleura and pulmonary tissue; the aspirator-needle, which has served as a guide, being withdrawn. The cannula of the trochar, of silver or vulcanite, should have a broad plate, by which it may be fastened by strings and plaster to the chest-wall. As free drainage of the cavity, more especially if it be basic, is the main object of the operation, this may be secured by leaving the cannula in the wound; or, if this be too short to serve as a free drain, it may be withdrawn and a rigid tube of some kind substituted. I have found a full-sized flexible prostatic catheter, cut of proper length, to be the most useful.

Should it be necessary to open up the lung-substance more freely, this may best be done by means of dressing forceps, as in Hilton's plan of opening deep abscesses. There will be less danger of hæmorrhage than if a scalpel be used. No antiseptics are needed when the contents of the cavity are already decomposing; free drainage is all that is required; and all antiseptics, if injected, irritate the bronchi and lung.' If the intercostal space be too narrow to admit the trochar, a piece of the rib must be removed. In operating with the knife, the lung must be fully exposed by taking away a part of one or more ribs. The pus having been found by an aspirator or fine trochar, a scalpel is pushed into the cavity along the guide thus obtained. The bleeding, though at first free, is easily arrested by temporary plugging or pressure. If there are no adhesions at the part exposed, Godlee recommends sewing the surface of the lung to the costal pleura.

Tapping the Pericardium.—In hydrops pericardii, attended with imminent danger of death from pressure, it will be necessary to **tap the pericardium.** This may be done by making an incision about half an inch in length through the skin and areolar tissue in the fifth intercostal space, in the cardiac region, and then slowly and carefully introducing a fine trochar at that point where percussion and auscultation have indicated the greatest amount of fluid. The trochar should be passed obliquely ; and, as soon as it appears to have entered the pericardium, the stylet should be sheathed and the cannula pushed forwards until the serum escapes.

The operation is, however, much more safely done with the aspirator. From experiments made on the dead body, Dieulafoy concludes that it may be performed in the fourth or fifth left interspace, the fifth being perhaps preferable, as it is nearer the apex of the heart and is a more dependent situation. The puncture may be made from 2 to 2½ inches from the left margin of the sternum. The spot having been selected should be marked with ink. If the patient be anasarcous, the interspace must be determined by carefully pressing away the œdema. The needle to be employed should vary with the case. If the diagnosis be certain, No. 2 (one millimetre, or roughly $\frac{1}{25}$ inch in diameter), should be used ; but if the diagnosis be uncertain, No. 1, half this size, should be chosen, as with this needle, it is said, the heart may be punctured with impunity. The best form of aspirator to use is one such as is represented in Fig. 93, as needles of such small size are apt to be plugged with small flakes of lymph, and if such an accident occur, they may be cleared again by reversing the syringe and forcing a small quantity of fluid back into the pericardium. Before using the aspirator, it should be carefully tested with some carbolized water to render it aseptic, and to see that the needle is pervious, and the whole apparatus in working order. A vacuum having been created in the aspirator by drawing back and fixing the piston, the needle is to be inserted at the spot determined on. As soon as the opening at the point of the needle is covered, the stop-cock leading to it is to be opened, so that the vacuum extends into the needle ; and "we now advance, vacuum in hand, in search of the effusion." The needle must be pushed slowly and carefully onwards in a direction upwards and inwards till the fluid appears in the glass tube of the aspirator. The moment this occurs all movement of the needle must cease, and it must be held steadily as long as the fluid continues to flow. Any unnecessary movement may scratch and injure the surface of the heart. If the flow cease suddenly, as if from some obstruction, a little fluid may be forced back as above stated, to clear the needle. After withdrawing the needle no dressing is required to the minute puncture. Over a pint of fluid has been removed by this means at one operation. In inserting the needle, care must be taken not to force it through a costal cartilage, or a small plug of cartilage may be cut out which would effectually close its canal.

CHAPTER LX.

DISEASES OF THE BREAST.

By **Disease of the Breast** is meant an affection of the mammary region, not merely of the mammary gland. These diseases may occur in the male as well as in the female. They are necessarily more frequent as well as more important in the latter, the rudimentary mammary gland of the male being little predisposed to such affections in comparison to the highly developed and active organ in the female.

Diseases of the breast, when they occur in the female, are of much interest to the Surgeon ; not only on account of their great variety, but from the difficulties attending their diagnosis, and from the importance attaching to the question of operative interference in connection with them.

Diseases of the breast seldom occur before puberty, being most frequently met with either during lactation, when the functions of the gland are in a high degree of development ; or towards the termination of menstrual life, when the organ is necessarily influenced by the changes that are taking place in the uterine system. But there is this important difference between the diseases at these different periods of life, viz., that in the young they are of a simple, in the older woman frequently, if not generally, of a malignant nature. Just before or at puberty, the breast occasionally becomes the seat of inflammation and abscess ; in all probability owing to changes taking place in it in connection with the general development of the reproductive system. As the period of puberty approaches, the breasts often swell, become hard, knotty, and somewhat painful, indicative of some commencing change in the generative system. In other cases again, a precocious hypertrophy may take place, frequently attended with severe neuralgia in the part. When puberty occurs, the breasts naturally enlarge, and often become tender ; and occasionally one undergoes a certain degree of hypertrophy, increasing greatly in bulk beyond the other. These various changes, though exciting alarm in females, cannot be regarded as of any very serious importance, and seldom require more than the simplest treatment.

ANOMALIES OF DEVELOPMENT.

The mammary gland is subject to certain anomalies in development. Thus, in some instances, most commonly associated with defective development of the chest walls, it has been found to be *altogether wanting*. Sir A. Cooper and Froriep both relate instances in which the organ was not developed, and in which the ovaries were also deficient. A more remarkable anomaly consists in the development of a number of **Supernumerary Breasts.** Birkett has collected fourteen reported cases, in which there were more than two breasts ; most frequently there is but one supernumerary gland, sometimes two ; and occasionally, though very rarely, three have been met with, constituting quintuple mammæ. **Supernumerary Nipples** have likewise been found to occur; two to each breast have been met with, each having ducts opening upon it. Most frequently the supernumerary breast is situated somewhere in the neighbourhood of the normal gland, as on the anterior part of the thorax; and where four are developed, they have been found placed in two parallel rows, one above the other. Occasionally they have been met with in very strange situations; thus they have been seen on the outer part of the thigh, in the groin, and on the back; and children are even said to have been suckled at these abnormal breasts.

NEURALGIA.

Neuralgia of the Breast occasionally occurs to so severe a degree as to constitute a positive disease, either in girls or at a more advanced period of life, when it not unfrequently complicates other more serious affections of this organ. It is especially apt to occur in young, delicate, unmarried females of the hysterical temperament, though it is often met with in strong, ruddy-looking women, who are perhaps subject to neuralgic pains in the back, and in other situations. Most commonly the catamenia will be found to be irregular; and uterine congestion, inflammation, ulceration, or displacement, will be discovered on examination; indeed, I have scarcely ever failed to detect one or other of these conditions in cases of neuralgic breast.

Symptoms.—In neuralgia of the breast, the mammary gland may be of its normal size and consistence; but in some instances it is more or less indurated and hypertrophied, owing evidently to chronic inflammatory thickening. There are always much general pain and aching, deeply in its substance, with cutaneous tenderness of its surface, and lancinating or radiating sensations that extend into the axilla and down the arm. These painful sensations are commonly increased before the menstrual period, and not unfrequently alternate in the two breasts.

Diagnosis.—The diagnosis of this affection from more serious mammary disease may usually be effected by attending to the neurotic temperament of the patient to the superficial and radiating character of the pain, to its shifting seat, and to the absence of any signs of organic disease sufficient to occasion it.

Treatment.—The treatment consists in attention to the condition of the uterine organs; unless this be done the disease will prove excessively rebellious and troublesome to manage. By removing by proper remedies any uterine irritation that may be found, this affection will be subdued with far greater readiness than by any purely local plan of treatment. At the same time, anti-hysterical constitutional remedies may be employed; the preparations of iron administered, when necessary; and the local pain relieved by the application of belladonna and opiate plasters, or by hypodermic injections of morphia.

HYPERTROPHY.

Simple Hypertrophy of the Breast is not unfrequently associated with very severe neuralgia of the organ. An increase of size, such as naturally takes place during pregnancy, between the fourth and ninth months, will occasionally commence at puberty, and go on until the organ attains an enormous bulk, as in Fig. 786, which represents the breast of a very thin girl of fifteen, who was under my care for this condition. In some cases the breast has been found after death to weigh as much as twenty pounds ; and after removal, a breast of this kind, taken from a young woman under thirty, has weighed no less than twelve pounds, being entirely composed of its normal tissues, greatly hypertrophied. In cases of hypertrophy both breasts are usually affected, though one is commonly more so than the other. The disease very rarely occurs after 25 years of age, and it comes on without any evident cause. The breast at first preserves its usual shape, though it is increased in bulk; but as it enlarges it gradually projects forwards, drawing down the skin of the shoulders, of the side of the chest, and even of the back, and hanging downwards, until it has been known to reach to the knees.

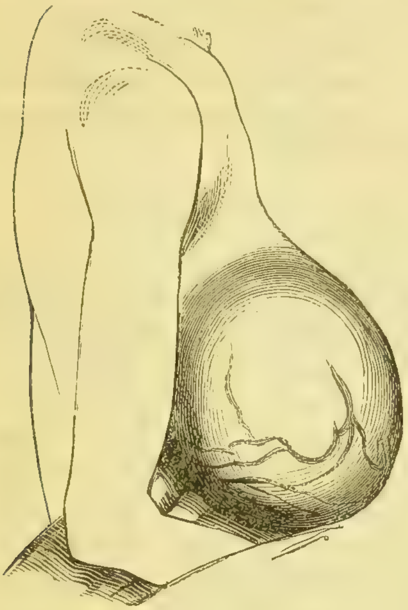


Fig. 786.—Simple Hypertrophy of Breast in a girl fifteen years old.

Treatment.—The treatment of this affection is very unsatisfactory. The general health must be attended to, and belladonna may be applied locally. Amputation of the organ should not be performed, unless the growth attain so great a size as to render life a burden. Then the mass may be extirpated with little trouble or danger.

ABNORMAL CONDITIONS OF THE LACTEAL SECRETION.

The lacteal secretion is occasionally the cause of abnormal conditions in the breast. Thus the milk may appear *at unusual times,* a twelvemonth, for instance. after weaning ; it has occasionally been known to be secreted in children, and in some remarkable instances in boys and men. In other instances again, after parturition, there is a total **Absence of Milk,** either owing to want of development in the gland, or to debility on the part of the mother. The opposite condition will occasionally occur, and an **Excessive Flow of Milk** may continue, especially in hysterical females long after the child has been weaned. In such cases as these, the *galactorrhœa* may be checked by the application of the extract of belladonna to the breast, aided by the employment of tonics, and the administration of acids.

Lacteal Tumour.—It may happen during lactation that one of the lactiferous ducts becomes obstructed, either by its being obliterated by inflammation or occluded by the deposit in it of a small concretion—a lacteal calculus. In either case the walls of the duct may be expanded, so that at last it constitutes a moderate-sized cyst, fluctuating on pressure, and evidently containing fluid. In some cases the lacteal tumour has been known to attain an enormous size. Walpy has related a case in which Scarpa drew off ten pounds of milk by tapping a collection of this kind. These tumours may exist for a considerable time. Dupuytren records an instance in which one had existed for ten months, and Cooper one of a year's duration. In these chronic cases the milk usually undergoes changes, becoming creamy, thick, and oily ; and in some instances it would appear to leave a solid caseous residue by the absorption of its watery parts, but this is very doubtful. In other instances the milk appears as if diffused through the substance of the gland and its ducts, constituting a spongy semi-fluctuating tumour. Velpeau believed that these lacteal deposits may become absorbed wholly or in part in some instances, in others remaining fluid, and occasionally becoming surrounded by a distinct fibrous wall, but probably the cases he described were chronic abscesses.

Treatment.—In these cases Sir A. Cooper advised making an oblique puncture from the nipple towards the cyst, by means of a trochar and cannula, so that a fistulous track might be left, along which the milk might be discharged ; the child being at the same time weaned, so that the secretion may cease. It is better, however, in all cases to make an opening through the skin and to treat the cyst by drainage.

INFLAMMATION OF THE BREAST.

Inflammation of the Breast may take place at any time of life, but the most common periods are within a few days of birth, at puberty, and during lactation in the adult, especially in feeble and anæmic women. Inflammation may affect any one of the parts of which the breast is composed, and may be limited to this : thus it may take place in the nipple ; in the subcutaneous areolar tissue lying between the skin and the gland ; in the gland itself ; or in that extensive plane of areolar tissue upon which the gland rests, and which intervenes between it and the pectoral muscle. But, although inflammation commonly affects these different parts, in many cases the whole of the breast appears to be involved, and no distinct implication of any special tissue can be made out.

Inflammation of the Breast in Infants. Mastitis Neonatorum.—In new-born children of both sexes the rudimentary breast becomes slightly swollen about the third or fourth day after birth, and on squeezing it a small quantity of milky fluid containing colostrum corpuscles can be made to exude. The secretion is most abundant about the tenth day and completely disappears before a month. According to Filatow this phenomenon is absent completely only once in about every 65 children. Inflammation of the breast may occur during this period in weakly children, especially if the tender breast has been squeezed or otherwise injured by an ignorant nurse. There are the usual signs of redness, increased swelling, heat, pain, and acute tenderness. Suppuration occasionally follows, and the pus may burrow widely in the subcutaneous tissue unless let out early, and death may ensue. Erysipelas is an occasional and very fatal complication. In females, mastitis neonatorum may lead to imperfect development or deformity of the nipple in after life. The *Treatment* consists in the application of warmth and moisture, and of belladonna. Should suppuration occur, the pus must be let out early by an incision radiating from the nipple.

Inflammation of the Breast at Puberty is not uncommon in boys as well as girls. It is subacute in character, accompanied by some pain, swelling and slight induration. It scarcely ever ends in suppuration, and is of little importance. It is best treated by the application of a belladonna plaster.

Inflammation of the Nipple and Areola.—When the nipple and areola are inflamed, these parts become conical, red, and swollen, with much pain, owing to the density of the subcutaneous tissue in this situation. This affection, "the cracked nipple" of nurses, usually occurs at an early period of lactation in delicate women, and especially with the first child. It commences in the follicles of the part, being accompanied by superficial ulceration, abrasion, and fissures, with oozing of a small quantity of thin sero-puriform fluid. There is great pain during suckling—so great, indeed, as to prevent the proper continuance of this act. It is usually attended by a good deal of constitutional irritation. In some instances, the fissured state of the nipple would appear to precede the setting in of inflammation ; in other cases, the inflammation is the primary condition. In wet-nurses the possibility of the occurrence of a primary syphilitic sore communicated by an infant suffering from the congenital form of the disease must always be borne in mind.

The *Treatment* is as follows. The child must be taken from the affected breast, both for its own sake and the mother's, the milk being drawn off by means of a breast-pump or sucker. The general health must be attended to ; tonics given ; the infant's mouth examined for aphthæ, which, whether as cause or as effect, are common, and must be treated on ordinary medical principles. If the nipple be not fissured, it should be covered with flexible collodion, or painted with an astringent; a solution of nitrate of silver, catechu, or tannin is the best. If it be fissured, a pointed stick of nitrate of silver must be applied to the bottom of the crack daily, or, if deep, its base may be divided by drawing a lancet along it. A nipple-shield, through which the child can suck, will often be found useful in preventing a recurrence after the fissure has been cured.

Abscess of the Areola not unfrequently occurs in suckling women, with the ordinary signs of local inflammation, terminating in circumscribed suppuration. The *Treatment* consists in the application of warm belladonna or lead lotion, and opening the abscess early. In doing this, care should be taken that the cut be made from the centre of the nipple towards the circumference of the areola, so as not to divide the lacteal ducts.

Small follicular inflammations and abscesses, varying in size from a pin's head to a cherry, are common in middle-aged women, independently of lactation. They often excite alarm, and occasion some pain. They are usually readily relieved by belladonna and glycerine or warm lead lotion, followed by the touch of the point of a lancet.

Eczema of the Nipple.—The nipple and the areola are not uncommonly the seat of very chronic and obstinate eczema. The eruption may extend to the surrounding skin. The cause of this condition is not always evident, but in some cases it is the precursor of cancer of the breast. (See Cancer of the Breast.) It not unfrequently attacks both sides. The *Treatment* is, as a rule, very unsatisfactory. The nipple must be carefully washed with tepid water. Glycerine of borax, boracic acid ointment with one drachm of extract of belladonna to each ounce, carbonate of lead ointment, and lead lotion may be tried, and often are of use. Painting the inflamed area occasionally with a strong solution of nitrate of silver may sometimes prove beneficial.

INFLAMMATION OF THE BREAST, which, as it generally occurs in nursing mothers, and terminates in suppuration, is usually called **Milk Abscess,** may occur in three situations : 1, in the Subcutaneous Areolar Tissue, **Supramammary Abscess**; 2, in the Gland itself, **Mammary Abscess**; and 3, in the Areolar Tissue between the Mammary Gland and the Pectoralis Major, **Submammary Abscess.**

1. **Inflammation, followed by Abscess, of the Subcutaneous Areolar Tissue of the Breast,** though common during lactation, occurs more frequently than any other form of inflammation in this region at other periods of life, more particularly about the age of puberty. Its symptoms are those of simple acute inflammation, differing in no way from abscess of this kind in other situations, except that it is always distinctly circumscribed.

2. **Inflammation of the Mammary Gland, Acute Mastitis,** is the most common form met with. It arises almost always in connection with lactation. Of 228 cases recorded by Nunn, Bryant, and Billroth, 181 occurred during suckling, 13 during pregnancy, and 34 independently of these conditions. It is most common in primiparæ, the tendency to it diminishing with each confinement. The right breast is more commonly affected than the left, and occasionally it is double. The causes of the inflammation are by no means certain. It has been supposed to be due to obstruction of a duct, and such an explanation is no doubt a very possible one, but there is no definite evidence in support of it. The fact that it is very frequently preceded by a sore nipple would suggest the possibility of its being due to extension from this, either by the lymphatics or ducts. It most commonly commences during the first four weeks after labour, or if that period be passed, towards the end of prolonged lactation, especially in weakly women. Hence it is very common amongst the poorer classes, amongst whom it is not rare to find children of from one to two years old still at the breast. It is rarely met with in mothers who do not nurse their own children, a fact which, as Billroth points out, is somewhat opposed to the theory that its common cause is obstruction to the flow of milk. The whole gland is rarely affected, but should this happen, it gives rise to great swelling of the breast, with severe aching and lancinating pain, and much constitutional disturbance, with considerable elevation of temperature. Much more often one lobe only becomes inflamed, most commonly at the outer or lower border of the gland. The local signs are then proportionately limited, and occasionally the inflammation subsides without reaching the stage of suppuration. As Velpeau has pointed out, one lobule after another may become inflamed, so that a succession of abscesses forms in different parts of the gland. As the inflammation advances to suppuration, the skin is reddened, assumes a dusky hue, becomes glazed, has a peculiar greasy appearance, and pits on pressure. There is marked febrile disturbance, and sometimes a rigor. When matter has formed, the tension of the superficial parts with œdema and fluctuation, perhaps deep-seated, determine its presence.

3. **Inflammation in the Areolar Tissue between the Mamma and the Pectoral Muscle** is of less frequent occurrence than the other forms of mammary inflammation. It arises in some cases apparently independently of any affection of the gland itself; but in most cases, as Billroth suggests, it is probably due to inflammation and suppuration of a deep lobule of the mamma. In whatever way it arises, the inflammation diffuses itself over the whole of the areolar layer, and almost invariably runs into abscess with considerable rapidity, giving rise to severe pain, of a deep, heavy, and throbbing character, much increased by moving the arm and shoulder, and attended by swelling, œdema, and a slight red blush upon the skin. The breast becomes prominent,

and is conical and projecting, the whole organ being pushed forwards by the pressure from behind; it is not readily movable on the pectoral muscles, the subcutaneous veins become engorged, and at last abscess forms. It is not always easy in these cases to determine whether suppuration has taken place or not, the depth at which the pus forms rendering it impossible in the early stages to detect fluctuation; its presence may, however, be suspected on the occurrence of deep-seated throbbing pain, subcutaneous œdema, and some superficial redness. The abscess at last points at some part of the margin of the gland, usually at its lower and outer side, to which point the matter seems to gravitate; after a time, however, it will commonly appear at other points of the circumference of the gland, beyond which it always extends, seldom, if ever, perforating the structure. A series of four or five apertures, forming a circle round the breast, may thus form, and it very commonly happens that these contract into sinuses, which are by no means easily closed.

Treatment.—In the treatment of puerperal mastitis, it must be borne in mind that we have to deal, almost invariably, with delicate anæmic women, weakened by recent parturition. It is therefore obvious that antiphlogistic means of an active nature are not admissible; and the best plan of treatment consists in keeping up the strength of the patient by constitutional support, at the same time that the inflammation is checked by topical antiphlogistic measures. The first thing to be done is to prevent if possible the occurrence of suppuration; if this can be accomplished, which is, however, rarely the case, much will be gained. In order to effect this, the breast should be supported in a sling, so as to lessen congestion of it; the arm at the same time being fixed to the side, in order to prevent traction of the pectorals and movement of the submammary areolar tissue. If the patient's strength be good, leeches may be put on, but these are rarely admissible. Hot fomentations should be assiduously applied from the first, and the whole breast painted with equal parts of glycerine and extract of belladonna; at the same time the milk should be drawn off by means of a breast-pump or sucker, the child being put only to the unaffected breast or weaned, and an occasional saline purgative administered. When suppuration is impending, the application of fomentations may be continued, the patient being allowed a more liberal supply of nourishment, with a moderate quantity of malt liquor; and, as soon as matter can be felt, it should be cut down upon and let out by an aperture in the most dependent position. The incision must always be in a line radiating from the nipple, so as to avoid needlessly damaging the ducts. It is of great importance that the pus should be let out early, by an opening into the lowest part of the abscess. A good-sized drainage-tube should then be inserted, and some efficient antiseptic dressing applied. If these precautions be not taken, the pus burrows deeply, diffusing itself through the areolar tissue, under, beyond, and around the gland, opening at several points, and leaving long fistulous tracks perforating the breast in various directions. When suppuration is going on, the patient's strength must be supported with tonics, the mineral acids, bark, or quinine. Stimulants may be given as required, and plenty of nourishment supplied. Should sinuses form in a case of mammary abscess they will usually close if the child be weaned, and lactation stopped. Should they not do so, the employment of pressure and the use of stimulating injections with attention to the general health will usually in time bring about a cure. Lacteal fistula is a very rare consequence of a mammary abscess. It closes readily when lactation has ceased. In cases of submammary abscess, the incision must be free, and a large drainage-tube should be used. Sinuses of an intractable kind more commonly follow this than the other forms of mammary abscess. In the event of their proving rebellious, it has been proposed to slit them up by free incisions directed towards the nipple; but this is unnecessarily severe practice, and may, I believe, in all cases be avoided. It will often be found that the delay in healing is due partly to the existence of a cavity beneath the mamma which is imperfectly drained by the sinuses. Under these circumstances, the orifices of the sinuses should be enlarged with a knife, and the tracks dilated with the finger. They should then be scraped with a sharp spoon to remove the unhealthy granulation-tissue, after which they should be cleaned with a piece of sponge soaked in chloride of zinc solution (gr. 40 to ℥j), held in a pair of sinus-forceps. A drainage-tube should then be inserted into each, and gradually shortened at each dressing. In some cases healing is promoted by the introduction of a small quantity of iodoform. The worst submammary sinuses may usually be speedily made to close by this treatment.

Chronic Inflammation of the Breast.—**Chronic Interstitial Mastitis.**—A form of chronic interstitial inflammation of the breast, affecting usually only a limited part of the gland, is not uncommonly met with in women past middle life, and is of great importance from the resemblance it bears in its clinical features to scirrhous cancer. The condition was first accurately described by Cruveilhier under the name of "fibrous bodies" (corps fibreux) in the breast; and since his time it has received many other names, such as Diffuse Fibroma or Hard Elephantiasis (Virchow), Lobular Hypertrophy (Sir A. Cooper), Knotty or Nodular Induration (Billroth), Cirrhosis of the Mamma, Benign Induration, &c. "Chronic lobular interstitial mastitis" is, however, the best name that can be applied to it, as it correctly indicates the nature of the affection.

The pathological appearances are very minutely described by Virchow. In the earliest stage, which is evidently inflammatory, the acini and ducts of the gland show no change beyond a slight increase in the epithelium. The connective tissue of the affected lobule is infiltrated with small round cells, which are most numerous in the immediate neighbourhood of the acini. In the second stage the new cells undergo development into dense fibrous tissue, like that of a cicatrix. This is accompanied, as in similar processes elsewhere, by shrinking of the tissue. The acini and ducts in the affected area are thus pressed upon. The epithelium undergoes fatty degeneration, and is for the most part absorbed, and thus a number of the acini are finally obliterated. Here and there, however, small retention-cysts form, chiefly from the ducts which have been constricted in places by the contracting fibroid tissue, while at the same time there has been a slight increase of secretion owing to the chronic inflammatory process going on in the surrounding areolar tissue. These cysts seldom reach a size larger than that of a mustard-seed, owing to the density of the tissue by which they are surrounded. The disease is very commonly limited to a single lobule of the mamma. Occasionally, however, it may be more diffused, and in such cases when the stage of shrinking is reached, the gland may become shrivelled and considerably reduced in size. The nipple may be retracted as the breast shrinks, thus still further increasing the resemblance to atrophic scirrhus.

The *causes* of the condition are very obscure. It is frequently associated with some menstrual disturbance, and is not uncommonly met with at the change of life. It is most common in women who have borne children.

The *symptoms* consist of the gradual formation of a tough, hard nodule in the breast, usually situated in the peripheral part, tolerably clearly circumscribed, and of rounded form. In size it may vary from a marble to a pigeon's egg, seldom being larger. It may distinctly increase in size at the menstrual periods, and diminish in the intervals. Its surface is often slightly nodular, the nodules being formed by the small, tense cysts already mentioned. If it be grasped and gently pulled upon with one hand while the nipple is held with the other, so as to make the ducts passing from it tense, it can easily be recognized that it is part of the mamma, and not an isolated tumour. On pinching up the skin over it, a dimple may form, as the areolar tissue of the subcutaneous at is continuous with that penetrating between the lobules of the mamma, which is involved in the interstitial inflammation. A similar nodule may not unfrequently be found either in another part of the same breast or on the opposite side. The disease may be painless, or may be associated with severe neuralgia, worse during the menstrual period. In the early stages there may be slight tenderness, but this is seldom marked, and is often wanting when shrinking is far advanced. There may in some cases be a slight enlargement of the axillary glands.

The *diagnosis* will be considered more specially with reference to cancer and adenoma. When it occurs below the age at which cancer is met with, its recognition does not as a rule present great difficulty. From adenoma it is distinguished by observing its less defined outline, and its connection with the nipple, showing that it is actually an altered piece of the mammary gland, and not an encapsuled tumour. If more than one lobule be affected, the diagnosis is more easy, as all true tumours of the mamma are primarily single. From a simple cyst it can usually be distinguished by its more leathery feel and less defined outline, but the diagnosis is not always possible. When from the age of the patient, the multiplicity of the tumours, the duration of the disease, or from its general features, it can be certainly stated that it is not a cancer, it may be left to time to determine its nature, but should there be the slightest doubt in the mind of the Surgeon that it is malignant, it is his duty to cut deeply into it without delay, and remove a piece for microscopic examination.

No *treatment* exerts much influence on the progress of the disease, but this is of less consequence, as beyond the neuralgic pain sometimes accompanying it, and the mental anxiety it often causes the patient, it is not likely to give rise to any inconvenience. Blistering, prolonged painting with iodine, and other forms of counter-irritation, produce little or no effect. Belladonna may be applied to relieve the pain. Pressure may possibly be of service in some cases. Probably the cases of so-called adenoma or cancer cured by pressure were in reality merely chronically inflamed lobules. Should it seriously annoy the patient, the affected lobule may be removed. If the breast is widely affected, no operative interference should be undertaken. In operating in these cases the incision should be placed so that if the disease be cancerous the whole mamma may be removed by enlarging the wound.

CHRONIC ABSCESS OF THE BREAST may assume two forms: the *Submammary* and the *Mammary* or *Encysted.*

Chronic Submammary Abscess of the breast may occur at all ages, in the single or in the married. It appears in the submammary areolar tissue, often without any external exciting cause, but as a consequence of impaired health, in strumous or cachectic females, and is often connected with uterine derangement. It may attain a very large size, and, pushing the mammary gland forwards, it gives the breast a conical, pointed shape. Fluctuation soon becomes apparent, and the ordinary local signs of chronic or cold abscess disclose themselves. Chronic abscesses in this situation may arise also in connection with caries or necrosis of a rib.

The *Treatment* of chronic submammary abscess of the breast consists in making a free outlet for the pus in a dependent situation, keeping it open with a drainage-tube, and dressing it by some efficient antiseptic method ; at the same time that the general health is improved with iron or cod-liver oil.

Chronic Encysted Abscess of the breast is a disease of great importance, inasmuch as it closely simulates various tumours in this situation ; so much so, indeed, that it is only with extreme difficulty that the diagnosis is effected in some cases. The breast has in numerous instances been amputated on the supposition of its being the seat of tumour, when the disease was merely a very chronic thick-walled abscess. This form of abscess usually, but not invariably, commences as the result of pregnancy, whether complete parturition or miscarriage take place ; sometimes as a consequence of lacteal inflammation, but usually without any injury or other direct local cause. An indurated indolent swelling forms, and this may gradually soften in the centre ; but fluctuation may for a long time be very indistinct, and even absent, being obscured by the thick wall of indurated tissue surrounding the collection of pus. It is owing to the dense inflammatory induration of the surrounding tissues, that the chronic encysted abscess is so commonly mistaken for a solid tumour. It is in general not very distinctly circumscribed, and of but moderate magnitude ; after a time it remains stationary during a space of many months or but slowly increases with but little pain ; it is not unfrequently attended with retraction of the nipple.

Diagnosis.—The error of mistaking a chronic abscess for a tumour may commonly be avoided by attention to the following points : 1, that the existence of an abscess is almost invariably preceded by parturition or miscarriage ; 2, that there is more or less œdema of the subcutaneous areolar tissue covering it ; 3, that, although it is of slow formation and without pain, it is not distinctly circumscribed, but gradually fuses in an irregular manner into the neighbouring tissues ; 4, that it is not freely movable, but rather incorporated with adjacent parts ; 5, that elasticity, or even deep fluctuation, may be commonly felt at one part of it ; and 6, in hard cancer, which it most closely resembles, the circumference is softer than the centre. In a chronic abscess or any fluid tumour, the centre gives the least sense of resistance. Should there be the least doubt in the case, the introduction of an exploring trochar, by giving issue to a drop of pus, will always determine its true nature ; indeed, this simple means of diagnosis should never be neglected in any case in which there is reason even to suspect the possibility of the apparent tumour of the breast being in reality an abscess.

Treatment.—The abscess should be opened as soon as recognized, and if of sufficient size a drainage-tube should be inserted. Should the mass of indurated tissue surrounding the pus be very large and dense, a free incision carried through it will usually hasten its disappearance.

In all cases of chronic abscess of the breast, but more particularly in the sub-mammary, the arm should be kept at perfect rest in a sling or bandaged to the side.

TUBERCLE OF THE BREAST.—A few cases of tubercle of the breast have been recorded by Duret, Dubar, Habermaas and others. The disease commences as an indurated nodule in the gland which gradually softens. On opening the chronic abscess thus formed curdy pus is let out and the cavity contracts but refuses to heal. Other centres of suppuration may form, and in some of the cases amputation of the breast has become necessary to remove the disease. In most of the cases there has been tubercular disease of the lungs. The lymphatic glands in the axilla have been enlarged in some. Habermaas has in two cases demonstrated the presence of the tubercle bacillus in the diseased tissues. The disease is evidently very rare, but it possibly has been overlooked, in many cases being described as chronic abscess. The treatment consists in opening the abscess and scraping away the diseased tissues. If this fails, and the abscesses are multiple, amputation of the breast is the best treatment.

SYPHILITIC DISEASE OF THE MAMMA.—**Primary Sores** on the nipple have already been mentioned. **Gummata** have been described in the mamma, and a few cases recorded. Billroth, however, does not regard the evidence of their occurrence as conclusive. There is no doubt that if they do occur they are of extreme rarity.

TUMOURS OF THE BREAST.

The study of the various tumours of the female breast, more especially from a diagnostic point of view, is of the first importance to the practical Surgeon: for though it might be supposed that it would be easy, if not to recognize the minuter shades of pathological difference between morbid growths so superficially situated, at all events to diagnose the malignant from the non-malignant affections, yet in practice nothing is more difficult in many cases ; and it not only requires great experience, but a most intimate acquaintance with the special course and symptoms of each particular disease, to come to a correct conclusion as to its nature. Even with all the light which experience and a careful examination of the characters of the tumour may throw upon the nature of the disease, it will be impossible for the Surgeon to avoid occasional errors in diagnosis.

The first thorough classification of the different varieties of simple tumours that develop in the mammary gland was made by Sir Astley Cooper, and this important department of surgical pathology was subsequently much extended by the researches of Velpeau, Birkett, and Paget. Since the improvements in the methods of investigation have led to a more perfect anatomical classification of tumours, the confusion that formerly surrounded this very intricate subject has been to a great extent cleared up by the labours of Virchow, Billroth, Gross, and others. The microscopic characters of the various tumours of the breast are now accurately determined and generally agreed upon, but confusion still remains in the nomenclature which time alone can remove. In describing the various tumours of the breast I shall follow the order adopted in the chapter on tumours in general.

NON-MALIGNANT TUMOURS.

Cysts of the Breast are of common occurrence. They occur either as independent tumours, or in conjunction with solid growths. To the former class belong Retention-Cysts, Serous Cysts, and Parasitic Cysts; to the latter, the cysts met with in "cysto-sarcoma," and the cysts in soft sarcomata.

1. **Retention-Cysts.**—These are formed by the gradual dilatation of the acini or ducts of the mammary gland. The "*galactocele*," already described (p. 744), belongs properly to this class of tumour. It is produced solely by obstruction to the exit of the natural secretion during lactation. The retention-cysts formed in the mamma at other times never contain milk. The fluid that distends them is usually thick, sometimes almost mucous in appearance, and usually of a brownish yellow or brown colour, and more or less turbid. It is an abnormal secretion from the gland-tissue. In galactocele the sole cause of the condition is obstruction of a duct, but in the cysts we are now considering, abnormal secretion is the primary factor in the production of the disease. The walls of these cysts are composed of a layer of connective tissue of variable thickness, containing usually an abundant supply of capillary vessels. They are lined internally by a layer of epithelium, either cubical, somewhat resembling that of the normal acini, or columnar, like that of the ducts.

As before stated, cysts of this class are frequently met with in lobules of the mamma affected by chronic interstitial inflammation (p. 749). They are usually multiple, and seldom reach any great size. They are also not uncommon in the indurated and atrophied breasts of old women, and when met with under these circumstances have been termed "*involution cysts.*"

Retention-cysts arising independently of these conditions, or **glandular** or **duct cysts,** as they are often termed, may be multiple or single. As a good example of the multiple form the following case may be given. A young unmarried woman, in order to quiet a baby she had charge of, put it occasionally to her breast. This was followed by some pain and swelling, and a thin yellowish discharge from the nipple. Some months after, on examining the breast, a number of small fluctuating swellings, the largest about the size of a hazel nut, could be felt scattered through both breasts. They were most distinct in the neighbourhood of the areola. The discharge continued, and was a source of considerable annoyance. On pressing the cysts their contents were easily squeezed out through the nipple. The condition remained unchanged for about two years, in spite of belladonna and other external remedies. She then married and became pregnant. As the breasts enlarged, the abnormal discharge gradually ceased, and after her confinement she was able to nurse her child without difficulty.

Single cysts of the same nature are not uncommonly met with, and may attain a considerable size. They form rounded or lobulated tumours, usually imperfectly defined and painless, or nearly so. When their contents can be squeezed out at the nipple they are usually soft and fluctuating. Should the duct become completely or partially blocked either from inflammatory induration of the surrounding tissue or, as in a case recorded by Rogeau, by a small papillary growth springing up in its interior, the cyst increases more rapidly in size, and becomes so tense as to be easily mistaken for a solid tumour. The causes of these cysts are uncertain. They seem usually to arise from some injury or irritation of the breast. Butlin, who has published some interesting observations on these cysts, states that they most commonly occur after thirty-five, in women who have borne children, and in several cases appear to have arisen as the result of a blow. In some cases they may possibly be associated with some uterine affection.

Cysts of this kind may become the seat of *intra-cystic growths*, composed of delicate branching papillæ, covered with epithelium of the same character as that lining the cyst-wall. These may at last completely fill the cavity, converting it into a solid tumour. These vascular papillæ readily bleed, and have probably been the source of the bloody fluid which has been described as escaping from the nipple in some of these cases. It is possible that these tumours may become malignant, and be the starting-point of a peculiar form of cancer with columnar epithelium, occasionally met with in the breast, to be subsequently described.

2. **Serous Cysts of the Breast.**—These are believed to be formed, as elsewhere, by dilatation of the lymph-spaces of the areolar tissue, the wall of the cyst being formed of the surrounding connective tissue pressed together and subsequently thickened by new growth. The evidence of this mode of growth is not by any means perfect, but it seems the only possible explanation of their structure. Their walls are composed of delicate areolar tissue, lined internally with flattened endothelial cells like those of a lymphatic vessel. The contents are usually clear yellowish serous fluid, but may sometimes be brownish or turbid, from the admixture of blood, and in some cases cholesterine is present. These cysts are usually single, sometimes they are loculated and in other cases multiple. They are usually about the size of a filbert when first noticed, and may remain small for a great length of time, but in other cases they gradually increase until they may contain several ounces of fluid. They then become very tense, so much so in fact that fluctuation is no longer present. The true serous cyst is almost invariably seated in the submammary areolar tissue, or at one margin of the breast, very rarely in the glandular substance.

Unilocular cysts of the breast occasionally attain an immense size, at the same time that their walls remain thin and supple. In these cases the skin covering them may become thinned and translucent, constituting the condition which has been termed *hydrocele of the breast*.

The simple serous cysts never develop intra-cystic growths. In some rare cases calcification of the cyst-wall has been observed.

3. The true **Hydatid Cyst** is extremely rare, but has been met with in the mamma. The simple serous cyst was described by Sir A. Cooper under this name.

The **Diagnosis of a cyst of the breast** may usually be effected by feeling the globular elastic tumour under the skin; the mammary gland being movable and not adherent to any of the adjacent structures. Cysts being connected with the mammary tissue drag upon the nipple when moved away from it. This is recognized by holding the nipple lightly while the tumour is drawn away with the other hand, when the connection between them will be clearly perceptible. In those cases, however, in which the tumour lies deeply, the diagnosis may not so readily be made, more especially from tumours containing cysts or cancer. In fact, nothing is more easy than to diagnose the true nature of a superficially seated, lax-walled cyst; nothing is more difficult than to recognize it when tense and deeply seated towards the under surface of the mammary gland (Fig. 787); for, the whole thickness of the gland intervening between the cyst and the finger, the sense of elasticity is lost and a solid feel communicated, which may readily mislead even the most experienced Surgeon. In a cyst, if elasticity can be recognised, it will be most distinct in the centre; in solid tumours the centre is the densest part. In examining the tumour the patient should be placed on her back, so that the mamma is flattened out and supported by the ribs. Elasticity and fluctuation are then more easily distinguished. Many errors in diagnosis arise from neglecting this simple precaution. Whenever the Surgeon has any doubt about the existence of fluid in a tumour of the breast, he should introduce an exploring trochar; when, if the disease be cystic, the fluid will be discharged. If the tumour prove to be solid, no ill consequences will result from the simple puncture. Several instances have occurred to me in which, from the want of this precaution, very excellent Surgeons have condemned as cancerous, tumours of the breast, which proved to be cystic.

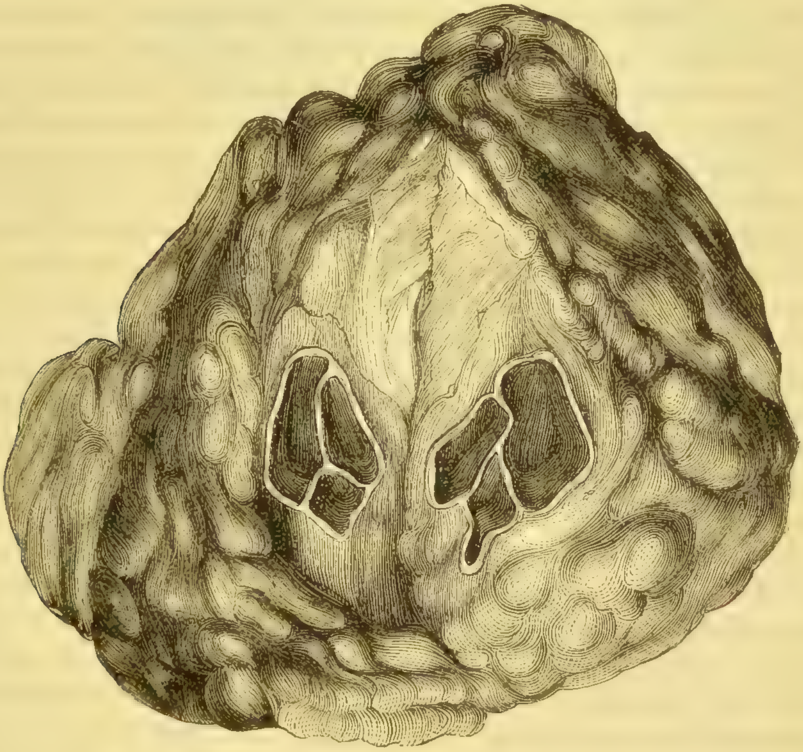


Fig. 787.—Breast laid open after removal, showing Cysts deeply seated in Mammary Gland, mistaken for Scirrhus.

The diagnosis of the retention-cyst from the simple serous cyst is not possible unless fluid can be squeezed from the nipple, a condition which of course cannot occur in the serous cyst. If this sign be wanting, the nature of the disease may be recognized in most cases by the character of the fluid. The true hydatid cyst is so rare that it may be practically excluded in making the diagnosis. It may be recognized by the character of the fluid withdrawn on puncture. This is clear, containing merely the faintest trace of albumen, and has a specific gravity of 1003 to 1004. Hooklets may possibly be found in it. Without puncture these cysts cannot be distinguished from the other forms.

The **treatment of cysts of the breast** varies according to their number and size and the presence or absence of intra-cystic growths. Small multiple retention-cysts which can be emptied through the nipple sometimes require no further treatment. Belladonna or some form of counter-irritation may be applied externally in the hope of arresting the abnormal secretion, but these means are seldom of much use. If the cyst is larger and cannot be emptied by pressure, the fluid contents may be let out by puncturing with a small trochar ; but a cure cannot usually be effected in this way, as the fluid re-accumulates. Occasionally it will suppurate spontaneously, and is thus got rid of. If the tumour be single, it may usually be cured by opening it by a small incision, wiping it out with a strong solution of chloride of zinc or tincture of iodine, and inserting a drainage-tube under an antiseptic dressing for a few days. If it seem to be surrounded by indurated mammary tissue, it is best to dissect it out and to remove it with the lobule of the mamma to which it is attached. On doing this it will often be found that the cyst is not single as was at first supposed, but that several smaller sacs are present which have been concealed by the larger one. If the cyst contain intra-cystic growths, it should be completely removed with the neighbouring part of the mammary gland. If the cysts are multiple they must be treated according to circumstances. If there are but two or three they may be treated as if single, but if very numerous there is nothing to be done but to remove the breast if operative interference is demanded.

Lipoma.—Fatty tumours have occasionally been met with in close proximity to the mamma, so as to simulate a tumour of the gland itself. A little careful examination will usually enable the Surgeon to ascertain that the gland is not implicated. The *Treatment* of these tumours presents nothing peculiar.

Fibroma.—Pure fibroma of the mamma is very rare. One case only has occurred in University College Hospital in the last fifteen years. The patient was a middle-aged woman, and the tumour, which was about the size of a hen's egg, was of stony hardness. It was thought to be a scirrhous cancer, but as there was some doubt, a deep incision was made into it before removing the breast. It was found to be exceedingly dense, creaked under the knife, and no capsule was recognized. After removal of the breast, it was found to be clearly defined and surrounded by a distinct but dense capsule, from which it could be dissected out, leaving the mammary tissue untouched. Microscopic examination showed it to be composed of pure dense fibrous tissue, without a trace of glandular structure.

Chondroma and Osteoma.—Tumours of the breast containing cartilage have been recorded, but are of extreme rarity. Billroth mentions a case of a large sarcoma of the mamma in which small nodules of true bone were found.

True Adenoma, that is to say a tumour composed of true racemose glandular tissue closely resembling that of the normal mammary gland, is a rare form of growth. In the few cases that have been recorded, the tumour has been situated at the circumference of the mamma, oval or lobulated in form, firm and elastic in consistence, and distinctly circumscribed. In most cases it has not attained any considerable size before removal. To the naked eye the section closely resembles that of the normal mammary gland. Microscopic examination shows acini lined with abundant epithelium, presenting much the appearance of the normal gland during lactation. Small ducts connecting several acini may be present, but there are no larger collecting ducts as in the normal mamma. In some cases cysts have been present, formed by the dilatation of the acini. Apparently true secretion never occurs from the glandular tissue. The cysts when present are sometimes filled with a creamy fluid formed by the fatty degeneration of the epithelium. In the Museum of University College is a specimen of this kind of tumour, five inches in diameter and weighing four pounds. It was removed by R. Quain from a lady aged 26 after about 18 months' growth. At the time of the operation the patient was in the sixth month of pregnancy. It was loosely encapsuled and not adherent to the gland or to the skin. Its section much resembles that of the pancreas to the naked eye, and microscopic examination shows the structure above described. It is distinguished from normal mammary tissue by the total absence of fat from the inter-acinous tissue. It contains one small cyst about half an inch in diameter with some fine papillary intra-cystic growths projecting into it.

Adeno-Fibroma, Adeno-Sarcoma, Cysto-Sarcoma. — A group of tumours closely related to each other pathologically, though differing considerably clinically, are included under these names. The essential features common to all are—first, the presence of spaces, either flattened and slit-like or forming distinct cysts, lined with a small cubical epithelium, usually in several layers but occasionally single (Vol. I., p. 1028, Figs. 381, 382). The spaces contain a variable amount of fluid, in some cases so small in amount as to be scarcely recognizable, in others distending the cavities into well-marked cysts, seldom exceeding an inch or an inch and a half in diameter. The bulk of the tumour is composed of the interstitial tissue between the epithelium-lined spaces. This tissue varies from fully developed fibrous tissue to the simplest embryonic tissue, and may present every stage between. Thus it may be composed of small spindle-cells with numerous fibres between them ; of imperfectly developed fibrous tissue infiltrated with small round cells or large spindle-cells ; of delicate fibres with stellate cells and mucous intercellular substance ; or of various combinations of these structures. Lastly, when the spaces develop into cysts, they often present intra-cystic growths of great size forming the most marked feature of the tumour. These growths are formed of processes of the interstitial tissue of the tumour projecting into the cyst and are covered with a layer of epithelium. They are often branched, and may in some cases completely fill the cavity into which they grow. They may sprout from all sides at once, and then form a closely-packed foliated mass, without any clear evidence of the mode of growth remaining. In other cases a pedunculated mass springs up from a single point in the cyst-wall, and may project into it, still surrounded by a certain amount of fluid, or may completely fill it, displacing the fluid and being surrounded by the cyst-wall as by a capsule.

In whatever way the tumour grows it remains, as a rule, completely surrounded by a capsule of areolar tissue, and forms no adhesions to the surrounding parts unless it be allowed to reach such a size as to excite inflammation by the pressure and tension it exerts.

Of the causes and mode of origin of these growths little is known. Billroth states that they commence by an overgrowth of the connective tissue surrounding the acini and ducts. But whatever point they may commence in it is evident that in their subsequent development the growth of the epithelium is as essential a part of the process as is that of the interstitial tissue. The presence of the epithelium-lined spaces is not a mere accident of the growth but an essential feature of it. These tumours are therefore properly termed adenomata.

The differences in anatomical structure correspond tolerably accurately to the variations in the clinical course of the growth. The more perfect is the development of the interstitial fibrous tissue, the slower is the growth of the tumour ; the more embryonic the tissue, the more rapid is its progress and the greater is the risk of its extending beyond its capsule, infiltrating neighbouring parts, and recurring in internal organs, in fact, running the course of a malignant sarcoma ; a termination which is, however, very rare in these cases. It not uncommonly happens that the tumour appears first as a small hard nodule, evidently with firm fibrous interstitial tissue, and may remain in this state for many years, scarcely increasing in size ; but after middle life it may suddenly take on rapid growth, and when removed its interstitial substance will probably consist of spindle-cells, or of some even more embryonic tissue.

The brief anatomical sketch above given will sufficiently explain the various names bestowed upon this class of tumours. When the tumour is of slow growth and firm, it is often called the *Chronic Mammary Tumour*, the name originally given it by Sir Astley Cooper. Abernethy, from the resemblance of the section in some cases to that of the pancreas, termed it the *Pancreatic Sarcoma*. Vidal termed it *partial or lobular hypertrophy of the mamma*. In this country it is most commonly termed the *Simple Adenoma*. The term *Adeno-fibroma* is, however, that which most accurately describes its anatomical structure, and is undoubtedly the best (Vol. I., p. 1028, Fig. 381). When the interstitial tissue is either embryonic or undergoing one of the primary modifications which embryonic tissue manifests in its development into fibrous tissue, in other words, when it corresponds to the structure characteristic of a sarcoma, the tumour is called an *Adeno-sarcoma* (Vol. I., p. 1028, Fig. 382), and when stellate cells are found, and the tumour yields on squeezing an abundant glairy mucous fluid, it is termed *Adeno-myxo-sarcoma*. When cysts form a marked feature in the growth, it is commonly termed a *cysto-sarcoma* of the mamma, but other terms are also applied to it. Thus Brodie termed it the *Sero-cystic sarcoma*, and Paget suggested the name of *Glandular proliferous cysts*. The term Cysto-sarcoma originally suggested by J. Müller is so generally adopted, that it is, perhaps, most convenient to adhere to it for clinical purposes, therefore, these three forms may be described ; the Adeno-fibroma, Adeno-sarcoma, and Cysto-sarcoma, remembering as Billroth says, that from a purely anatomical point of view, the difference between these is very slight, and that we should be perfectly justified in considering the Adeno-fibroma as the initial stage of the other forms.

The **Adeno-fibroma** is the most common simple tumour of the breast. It is often attributed to blows, squeezes, or lacteal irritation, and is most commonly met with in young women under thirty years of age ; usually in women otherwise healthy. Bryant states that of 100 consecutive cases observed by himself, 27 were first discovered between puberty and 20 ; 35 between 20 and 30 ; 22 between 30 and 40 ; 13 between 40 and 50 ; and 3 after 50. Forty-six occurred in single women, 37 in the married and prolific, and 15 in the married and sterile. It is often associated with the hysterical temperament, and connected with, if not dependent on, uterine irritation and sexual excitement of an irregular kind. This tumour is generally of small size when first perceived, and may remain stationary for many years; or it may slowly increase, and at last attain a considerable bulk. In other cases it may very rapidly grow to a great size. In a case on which I operated some years ago, the tumour had continued for eighteen years about the size of a walnut, but in the course of six months it increased to an enormous magnitude, and on removal weighed nearly five pounds.

This tumour usually commences as a small, movable, finely nodulated growth, attached by a pedicle to one side of the mammary gland; it is hard and incompressible, often appears isolated, and is not generally painful, but in anæmic women may be the seat of intense neuralgic pain; it increases slowly, without discolouring the skin or becoming attached to it, and is frequently many years in attaining a moderate size. It is often floating, as it were, in the substance of the gland, into which it can be pushed back. This tumour is sometimes mistaken for a cancerous growth, and the diagnosis is often as difficult as it is important, though in many cases the comparative youth of the patient, the mobility of the mass, the absence of all implication of the skin and glands, and its accurately circumscribed character will indicate its true nature. Cysts and chronic interstitial inflammation of a lobule are often mistaken for adenoma, and in many cases the distinction is very difficult. The diagnosis is made by the more accurate circumscription of the fibro-adenoma, and by its being usually clearly separable from the mamma, and not connected with the nipple by a cord of duct which can be felt on drawing the tumour away from the nipple while that is gently held between the finger and thumb.

On examination after removal, an adenoma appears to be irregularly lobulated, is enclosed in a capsule of areolar tissue, and its cut surface is found to present a bluish- or greyish-white colour, which after exposure to the air, assumes a rosy tint; and on pressure, drops of a thick mucous or serous fluid are often seen to exude. On examination with a lens, its foliated structure is often very apparent, so much so, that it has been compared by Virchow to the section of a cabbage. This is more clearly seen after it has been a few days in spirit.

Adeno-Sarcoma.—An adeno-fibroma, though usually chronic in its progress, may at times assume extreme rapidity of growth, so as to simulate a soft cancer. This happens usually in those cases in which the tumour has remained in a quiescent state from an early period up to about the middle of life. In cases in which the disease develops for the first time between the ages of 35 and 40 it may grow quickly from the first. In these cases it will grow with extreme rapidity, attaining in a few months a size equal to that of a cocoa-nut, or even larger, and simulating in this respect the progress of an encephaloid tumour. These rapidly growing adeno-sarcomata are painless, and, as a rule, however large, continue perfectly movable, free from deep adhesion, or from glandular implication; the skin covering them is healthy, thinned, and unadherent, the nipple projecting usually very prominently. The tumour itself will be felt to be nodulated, semi-elastic, not stony, and always rounded in outline. After removal its section is lobulated and glistening, something resembling a mass of sago-jelly, often having cysts interspersed through its substance.

Painful Mammary Tumour.—It occasionally happens that an adeno-fibroma becomes the seat of very severe and paroxysmal neuralgic pains, attended with very considerable cutaneous sensibility, and it has then been termed the *painful mammary tumour.* This condition most frequently occurs in early life, and in women of an irritable and delicate constitution ; it is commonly associated with disorder of the uterine functions, the pain increasing at the catamenial periods.

Treatment of Adeno-Fibroma and Adeno-Sarcoma.—If the tumour be firm and small, and show no tendency to further increase, it may be let alone, unless it be a source of mental disquiet to the patient. If it assume the form of the painful mammary tumour, it is better to remove it at once, unless the patient's general health is such as to contra-indicate immediate operation. If this be the case, the treatment must be directed to the removal of the neuralgic condition. This is commonly best effected by the internal administration of alteratives and tonics, more particularly the preparations of iron and zinc, with cod-liver oil if necessary ; and by the inunction of an ointment of belladonna or aconite into the affected breast.

Adeno-fibromata are said to have occasionally disappeared, and in some instances to have been spontaneously absorbed after marriage or during pregnancy. The internal administration of Plummer's pill and the compound decoction of aloes, and the external application of leeches, followed by the inunction of iodide of lead ointment, and the employment of pressure, either by means of Arnott's slack air-cushion or by Tanchou's spring pad, are said also to have caused absorption of these tumours. I have employed pressure in the treatment of solid nodules in the breast with undoubted advantage, but it is probable that these were not true adenomata, but indurated lobules of the breast due to chronic interstitial inflammation, a condition which was formerly not clearly distinguished from adenoma. There is no doubt that the cases of so-called "cancer" cured by the same means, were also in reality lobules of the mamma indurated by chronic inflammation.

The only efficient treatment of an adeno-fibroma, or an adeno-sarcoma, is its removal by excision. In doing this the tumour must be exposed by a single incision radiating from the nipple, so as to injure the mammary tissue as little as possible. The loose capsule of areolar tissue surrounding the tumour must be thoroughly opened, after which it can often be shelled out without further use of the knife. There are usually few vessels to tie. In exceptional cases the growth may be adherent to the breast by a pedicle, necessitating the removal of a small lobe of the mammary gland. As these tumours usually lie at the margin of the breast, or sometimes deeply beneath the mammary tissue, the loose submammary areolar tissue between the gland and the pectoralis major is often opened up. When the tumour is seated more superficially this may possibly be avoided by keeping the knife close to it in dissecting it out. When the submammary tissue is opened up it is very important to prevent extravasation of blood into it, or the occurrence of suppuration, which might be followed by burrowing of pus behind the mamma of the most troublesome and tedious character. This accident is avoided first by the strictest attention to antiseptic precautions during the operation ; secondly by perfect arrest of all bleeding before closing the wound ; thirdly, by the insertion of a drainage-tube after closing the wound ; and lastly, by the application of an absorbent antiseptic dressing exerting uniform elastic pressure on the wound. Iodoform, salicylic or sal alembroth wool give equally good results. The dressing should not be disturbed till the fifth or sixth day, when the drainage-tube may be removed. Under this treatment suppuration is a very rare complication.

In cases of adeno-sarcoma which have been allowed to attain a very large size, it will generally be necessary to extirpate the whole of the mammary gland, which will be found either involved in the tumour, or in an atrophied but otherwise healthy state. It is surprising with what ease these tumours can often be removed, even when they have reached some pounds in weight. They rarely form any deep attachments, and adhere to the skin only when the tension has become so great as to set up inflammation.

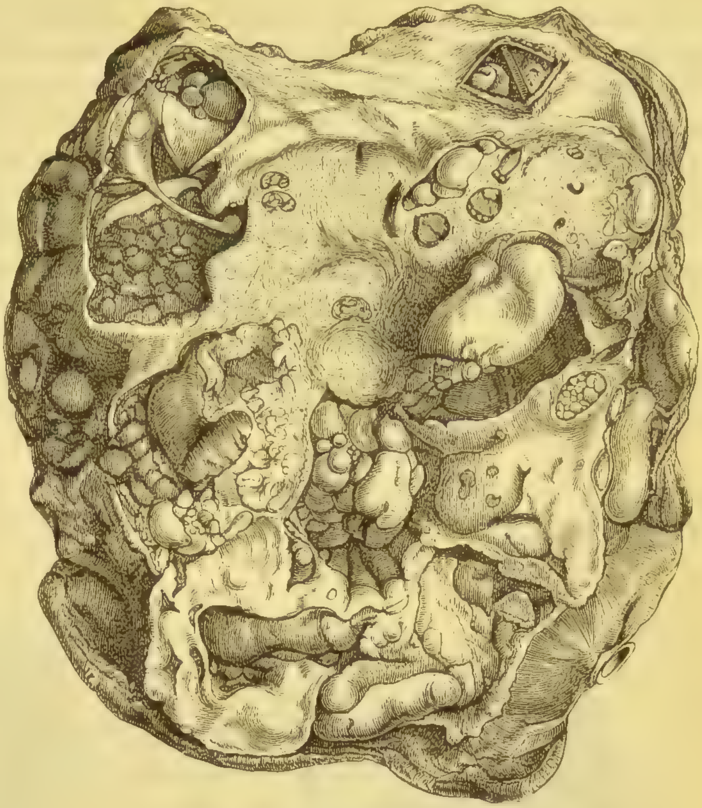


Fig. 788.—Cysto-Sarcoma of mamma, showing large cysts with intra-cystic growth.

Cysto - sarcoma. — These tumours are composed of dense white lobulated or foliated structure, resembling that of the adeno-fibroma. This mass is studded throughout with a number of small cysts, varying in size from a pin's head to an inch and a half in diameter, and

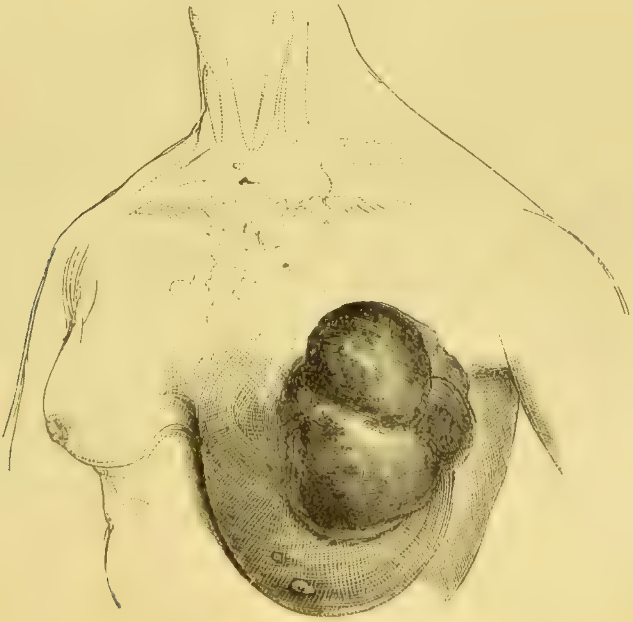


Fig. 789.—Cysto-Sarcoma of Breast.

usually containing clear fluid. The larger cysts contain lobulated, branching, intra-cystic growths, most commonly sprouting from one side only, and forming pedunculated projections into the cavities. These intra-cystic growths are not always present. This form of tumour is usually met with in women of from thirty to thirty-five years of age, and is often attributed to injury. It occurs most frequently in women who have borne children, and is possibly a remote consequence of some inflammatory process occurring during lactation. On examining a breast affected in this way, it will be found that the tumour is hard, heavy, and solid to the feel; on careful examination, however, its surface may be felt to be finely nodulated; and, occasionally, a larger cyst than usual, recognised by its elastic feel and globular shape, may be found projecting. The disease is slow in its growth, and does not implicate the adjacent cutaneous or areolar structures; hence, the tumour is movable on the pectoral muscles, and the skin is unattached to it. The axillary glands, also, are not enlarged.

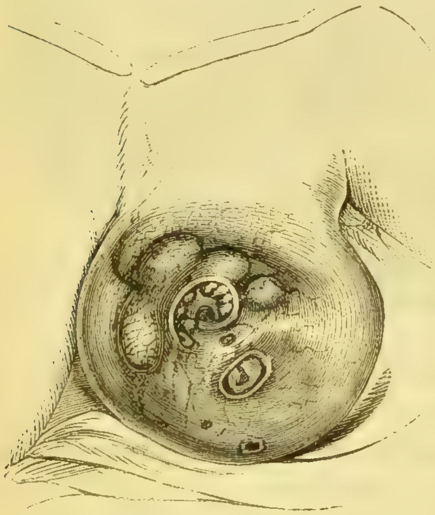


Fig. 790.—Ulcerated Cystic Tumour of Breast, of 20 years' duration.

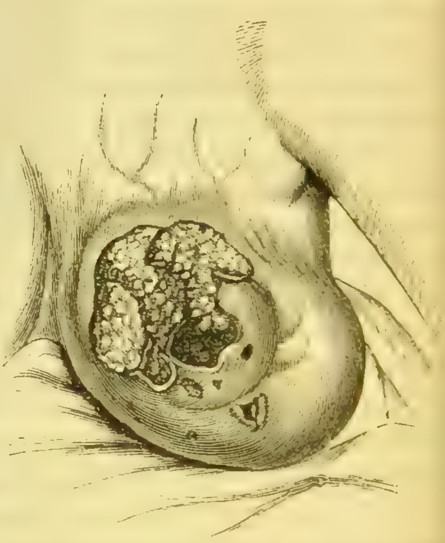


Fig. 791.—The same Cystic Tumour, six months later, with fungating sarcomatous growth.

The nipple will usually be found to be normal in its shape, and not depressed. If one of the larger cysts be laid open, or if the pressure of the intra-cystic growth causes inflammation and ulceration of its capsule, this may at last be perforated, and a fungous mass will sprout through it, presenting many of the ordinary symptoms of a malignant growth; being irregular, dark-coloured, bleeding readily, and increasing rapidly in size. When such changes as these have taken place, the tumour assumes a formidable character, and will rapidly prove fatal by exhaustion. A cysto-sarcoma may attain an immense magnitude and weight. They have been met with of six, eight, or even twelve pounds weight; but by far the largest is one described by Velpeau, which weighed forty pounds.

The eventual development of fungating sarcomatous tissue in these tumours must not be overlooked. A tumour of this kind may remain benign for many years, and remain so generally throughout the greater portion of its structure: yet after removal soft sarcomatous masses may be found sprouting up into some of the cysts. In the case from which the drawings (Figs. 790, 791) were taken, the tumour had existed for more than twenty years before removal, having commenced at the age of twenty-eight; but after extirpation soft fungating growths were found at the bottom of some of the cysts. The constitution was uncontaminated throughout.

There is no *Treatment* for these tumours but early and complete removal. If taken early enough, the mamma can usually be saved, but when the growth has passed a certain size, this is no longer possible.

Sarcomata of the Breast.—The mammary gland or its immediate neighbourhood is a frequent seat of sarcoma. By far the most common form met with is the spindle-celled sarcoma, usually of the large-celled type. Sometimes the firmer form of spindle-celled sarcoma, with small cells and a varying amount of fibrous stroma—the old recurrent fibroid—is met with in this region. Small round-celled sarcoma, alveolar sarcoma, and giant-celled sarcoma, are also met with in this region, but are all rare. The structure of these various forms of sarcoma has already been fully described in the Chapter on Tumours (Vol. I., p. 1031 *et seq.*).

Most sarcomata of the breast are distinctly encapsuled by a layer of fibrous tissue in the early stages of their growth, but later on they tend to spread beyond this, and infiltrate the surrounding structures.

Sarcomata are difficult to distinguish from the softer forms of adeno-fibroma, and are practically indistinguishable from the adeno-sarcomata till after removal. Usually, they develop in women after thirty. They form soft, elastic tumours, smooth on the surface, and uniformly rounded or oval in outline. They may be deeply buried in the substance of the gland, but more frequently they are situated at one side. They are painless and movable over the pectoralis major until they have reached a considerable size, and they show no tendency to infect the lymphatic glands.

Sarcomata here, as elsewhere, may develop cysts in their substance from softening or from hæmorrhage. These accidental cavities must not be confounded with the cysts of a cysto-sarcoma. Microscopically they can be distinguished by the absence of an epithelial lining. Sometimes the whole tumour may be so soft as to be indistinguishable from a collection of fluid. In a case of this kind under my care a small puncture was made; nothing but blood escaped, and in a few weeks a fungating sarcomatous growth protruded from the opening. The breast was removed, and the growth was found to be an exceedingly soft sarcoma, the structure of which was to a great extent broken down by hæmorrhage.

These tumours present the most typical examples of recurrent sarcomata. It may be stated broadly that the softer the sarcoma the more rapidly will it recur. In one case, in which I removed a very large tumour of this kind, weighing about four pounds, with the whole of the involved and atrophied mammary gland, from a lady forty years of age in 1859, recurrence took place in 1861, and again in 1863, 1864, 1865, and 1868. The recurrent tumours were developed at some little distance from the original cicatrix, and proved on careful examination to be sarcomatous. The general health continued perfectly good throughout, and there was no infection of the lymphatic glands. She died of paralysis some years after the last operation. In these cases this absence of all glandular implication or of constitutional affection from secondary growths in the viscera will indicate the character of the disease; the peculiar local malignancy not being associated with any tendency to general infection. The tendency to recurrence may gradually wear itself out, and after several operations have been performed at intervals of months, or a year or two, the disease will cease to be reproduced, and a cure will be thus established. The result is not, however, often so favourable. Instances are very numerous in which the tendency to local reproduction is so active that it outruns all possibility of complete extirpation, and eventually destroys the patient. Moreover, whenever a sarcoma is not only exceedingly rapid in its growth, but recurs after removal, suspicions of general malignancy not unnaturally arise, as two of the most frequent and important elements of such a condition, exuberant vegetative activity and local return, exist. In a case under my care a few years ago, I removed a sarcoma about the size of a hen's egg from the mamma of a middle-aged unmarried lady. The tumour was distinctly encapsuled, and was easily dissected out. It was soft in structure, and yielded a glairy fluid from the cut surface, and was composed of large oval and spindle-shaped cells with scarcely any intercellular substance. A few months after five small soft tumours sprang up around the cicatrix. The whole breast was then removed, but the patient died a year afterwards from a large secondary growth implicating the sternum.

The **Prognosis in Sarcoma of the Breast** is always grave. Gross has collected the statistics of 156 cases, 91 of which were operated upon. In 42 of these recurrence occurred. In 6 the recurrence was in distant parts only; in 11 both locally and in distant parts, and in the remainder the disease returned as far as was known in the region of the breast only. In 3 cases only of the 156 were the axillary glands affected.

The **Diagnosis of Sarcoma of the Mamma** from the softer forms of adeno-fibroma and adeno-sarcoma, is not possible in many cases before removal. It may be suspected when the tumour is uniform in outline, free from lobulation, of rapid growth, and commences after the age of thirty-five. From cancer it is distinguished by its softness, its more rapid growth, its more definite circumscription, and the absence of glandular affection and of retraction of the nipple. Should the sarcoma from the first infiltrate the surrounding tissues, the diagnosis becomes much more difficult, as the growth closely resembles some of the softer forms of cancer.

The **Treatment of Sarcoma of the Breast** is early and free removal. Nothing else can be of the slightest use. Before commencing the operation it is well to obtain the patient's consent to complete removal of the breast if necessary. The tumour may then be exposed and dissected out. If it be firm and distinctly encapsuled, it may be removed without taking away the whole mamma, the capsule, if possible, being removed with it; but should it be soft, ill-defined, very vascular, it is safer to remove the whole gland at the same time. Should recurrence take place, the breast, if not already taken away, must be fully removed, and the operation may be repeated as often as local recurrence takes place, so long as there is no evidence of secondary growths in the viscera.

Sanguineous Cysts are occasionally met with in the mamma. These are of various kinds. As before stated, retention-cysts with papillary growths within them may become filled with blood, which may be squeezed from the nipple by pressure on the tumour. Very soft sarcomata also may be so broken down by hæmorrhage into their substance as to be mistaken for blood-cysts. A peculiar form of cancer to be subsequently described, which seems to arise rather from the ducts than the acini, may also present numerous cysts filled with blood. Lastly, any form of cyst may become filled with blood as the result of an injury.

Fœtal Remains have, in some rare cases, been met with in the breast; these, however, are merely matters of pathological curiosity.

CANCER OF THE BREAST.

Glandular cancer, that is to say, cancer the cells of which belong to the type of glandular or spheroidal epithelium, is the form commonly observed in the mamma. Its three varieties, scirrhus, encephaloid, and colloid, are met with, but the first occurs with far greater frequency than any of the other forms. The encephaloid form of the disease is occasionally met with ; but colloid is very rare. Colloid epithelioma, arising in a duct, or as it has been called, duct or villous cancer is another very rare form. Cancer of the breast, whatever form it assume, is invariably primary : it may affect one lobe only or be infiltrated into the whole gland, and it may commence in or immediately beneath the nipple, or so early affect the skin and spread so widely in it as to appear to have originated in that structure. Most frequently one breast only is affected, but in some cases both are implicated.

Scirrhus is the form of cancer which is commonly met with in the breast. It occurs in three forms : 1, Nodular or circumscribed scirrhus ; 2, Infiltrating or diffuse scirrhus ; 3, Atrophying or atrophic scirrhus.

Nodular or Circumscribed Scirrhus is the most common form. It commences as a hard circumscribed tumour, at first of small size and often of rounded form, indolent in character and with little or no pain. It is at first readily movable, but careful examination shows that it implicates the substance of the gland, and cannot be separated from it. Occasionally it may be situated in an outlying lobe, and appear to be attached to the rest of the gland by a distinct pedicle. As it increases in size it becomes hard, knotted and irregular or perhaps finely granular on its surface. It more definitely implicates the substance of the gland and forms adhesions to the skin covering it, and later on to the structures beneath it.

Infiltrating or Diffuse Scirrhus commences as a diffused induration of a considerable portion of the breast. Occasionally it may begin as a number of separate nodules, which quickly coalesce. In this way a mass is formed of irregular form, hard, rugged, nodulated and heavy. It quickly increases in size, and forms adhesions to the skin and deeper structures.

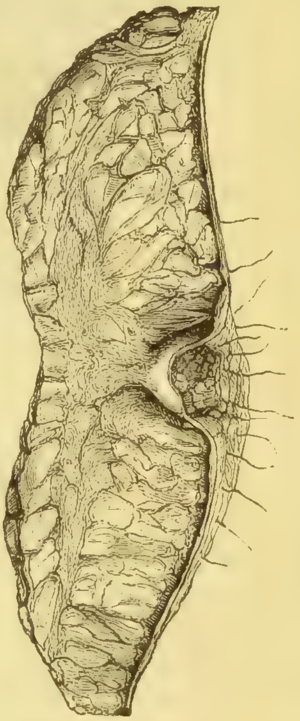


Fig. 792.—Atrophic Scirrhus of the Breast, showing deep retraction of the Nipple.

Atrophying, Withering or Cicatricial Scirrhus is more common in old women, but may occur at any age. The tumour is of slow growth, and is characterised by a peculiar tendency to shrink from atrophy of its central parts. In this way the affected breast, in spite of the presence of the tumour, may be greatly reduced in size, and may apparently almost completely shrink and disappear. The adherent nipple and skin are deeply drawn in.

Cysts occasionally form in scirrhous tumours in consequence of softening of the central parts of the growth. This is most common in the infiltrating form, and is never met with in the atrophic. In a woman, whose breast I once removed for what was supposed to be a cystic sarcoma, but which proved after the operation to be a scirrhous tumour, the mass contained several cysts as large as cherries, filled with dark or greenish fluid, and projecting from its surface; and in a lady under my care for scirrhus of the breast, a tumour as large as a pigeon's egg, containing sanguinolent fluid, formed on the surface of the tumour.

Course of Cancer of the Breast.—As the tumour increases in size, it has a tendency to be more fixed to the subjacent parts, becoming adherent to the pectoral muscles and incorporated with the areolar tissue at the border of the axilla. In the nodular and infiltrating forms the tumour also begins to form a distinct external projection, and becomes more irregular in shape; it is the seat of severe pain, more particularly at night; and is in some cases covered by a plexus of blue and dilated veins. The ordinary symptoms of cancerous cachexy now appear, and the disease then makes still more rapid progress.

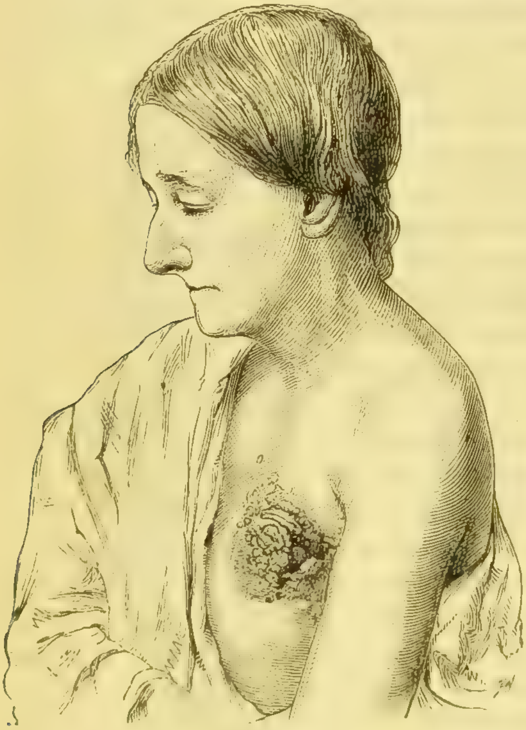


Fig. 793.—Ulcerating Scirrhous Cancer of Breast.

The tumour may in some cases remain for a great length of time without implicating the **Skin**; but most commonly, after it has existed for a few months, this tissue becomes more or less involved. Instead of being loose and movable over the surface of the cancer, it will be found, on being pinched up between the fingers, to dimple at one part, where it may be felt to be attached by a kind of cord-like process to the tumour beneath it. After a time, that portion of the skin which first became fixed in this way acquires a reddish or purplish colour, and is covered with thin scaly epidermic desquamations, and becomes permeated by a number of small ramifying vessels. A crack or fissure eventually forms in this; a small exudation of serous fluid takes place, which dries into a scab; under this, ulceration sets in, which speedily assumes the ordinary characters of a scirrhous ulcer, having hard, elevated, and everted edges, a greyish-green or foul surface, and discharging a quantity of very fetid pus. In the diffuse form ulceration may take place at several points, and thus the whole surface of the breast becomes converted into one immense chasm, which may extend even up into the axilla.

In some cases the cancerous development seems to expend its energy chiefly upon the cutaneous structures. The tumour of the gland is small, atrophic, and implicates the nipple. The cancerous infiltration rapidly spreads into the surrounding integument, which becomes early contaminated, assuming a hard, leathery character, or feeling brawny and infiltrated; often without discoloration, but presenting a hypertrophied appearance, the pores being enlarged, and the interspaces between them increased. In other cases, the infiltrated skin assumes a brownish or purplish colour, and is covered by rough desquamating crusts, so as to resemble the bark of an old tree. This diseased state of the integuments will extend very widely, without ulceration or further development of the tumour situated in the gland. I have in this way seen the integuments of the whole front of the chest, from the clavicles to below the mammæ, and from one axilla to the other, infiltrated, hard, and leathery, of a brownish-red colour, forming a stiff cuirass, as it were, but without ulceration. This condition, to which the name cancer "*en cuirasse*" has been given, is very chronic ; and it is remarkable that in it the axillary glands are not infiltrated, or the constitution rendered cachectic, at nearly so early a period as when the disease more extensively implicates the mammary gland.

Another way in which the skin becomes involved is by the formation of a scirrhous tubercle or nodule in it towards the outer or axillary border of the mamma, the gland beneath being implicated to but a limited extent. It is probable that in these cases the disease commences in an outlying lobule of the gland situated immediately beneath the skin. Occasionally small isolated tubercles spring up in the skin around the spot first implicated. They are of a reddish-brown colour, slightly elevated, smooth on the surface, and very hard. By the coalescence of these the condition above described of widespreading implication of the skin may arise.

The **Pain** is in many cases but trifling in the early stages of the affection ; so much so, indeed, that it is the tumour, often accidentally noticed, that first excites alarm ; as it increases, however, the suffering becomes severe, more particularly at night, is greatly aggravated by handling the diseased mass, and chiefly extends up to the shoulder and down the arm. The pain usually becomes most severe about the time when the skin is first implicated ; but, as the cutaneous infiltration goes on, it gradually lessens, owing probably to the destruction of the cutaneous nerves.

Retraction of the Nipple commonly commences about the same time that the skin is implicated. It is most marked in the atrophic forms of scirrhus. It is due to the shrinking and contraction of the older parts of the growth, which forms so characteristic a feature of scirrhus (Vol. I., p. 1058). As this takes place the ducts passing from the affected part of the gland to the nipple become dragged upon. The depression may be at the same time increased by the projection forwards of the general mass of the breast, so that the nipple may become completely buried. This sign has received more importance than it deserves in connection with cancer, as it does not occur in all cases of malignant disease, and is occasionally met with in simple inflammatory affection of the breast.

The **Axillary Glands** usually become enlarged early in the disease, and may attain a greater size than that of the original tumour ; and on close examination a kind of indurated cord may, in rare cases, be felt extending in the course of the lymphatic vessels, from the edge of the pectoral muscle to the axilla. After a time, the supraclavicular glands may likewise become implicated. When this is the case, the pressure upon the axillary vein may occasion œdema of the arm and hand. The glandular infiltration usually increases rapidly after the skin has become implicated. In some cases, when the glands become affected, the chief virulence of the disease appears to expend itself upon them ; the tumour of the breast ceasing to enlarge, or even wasting, whilst the secondary growths in the axilla become greatly developed. It is probably in this way that the supposed cases of primary scirrhus of the axillary glands have arisen.

As the scirrhus extends it may gradually implicate the subjacent muscles, areolar tissue, the ribs, and at last the pleura, giving rise eventually to hydrothorax.

After the affection of the lymphatic glands, secondary growths make their appearance in the **Viscera** and **other parts of the body**. The period at which this takes place varies in different cases. As a rule it may be stated that the softer the tumour and the younger the patient the earlier will the viscera be implicated. The most common seat of the visceral tumours is the liver; after that, but at a considerable interval, comes the lung and then the bones. In the brain, kidneys and other organs secondary growths are occasionally met with, but are less common. Among the bones, the femur, the ribs and the vertebræ are perhaps the most frequently affected. In the last situation it causes death by development of angular curvature, with pressure on the spinal cord. In the long bones it gives rise to spontaneous fracture.

The **Constitutional Cachexy** is, in the majority of cases, not present till after ulceration has taken place or secondary growths have formed in the internal organs. In fact, in the majority of cases the patient has enjoyed exceptionally good health, and appears perfectly healthy in other respects at the time the tumour is first discovered, and may remain so till it has made considerable progress. The implication of the skin is usually an epoch of peculiar importance in scirrhus of the breast, as it is at this period that the pain increases, the lymphatic glands become infected, and the constitution becomes distinctly poisoned.

Duration.—The duration of life after the occurrence of scirrhus of the breast varies greatly; so much so, that the disease may be considered as assuming an acute and a chronic form. The acute variety occurs principally in ruddy and plethoric women, and commonly proves fatal in a few months. In those who are of a more feeble and delicate constitution, the disease, as a general rule, takes a slower course. Sir A. Cooper states that the disease, on an average, is from two to three years in growing, and from six months to two years in destroying life after being fully formed. In this estimate, which is probably correct, Walshe agrees. Paget states that the average duration of life in cases in which the disease is allowed to run its course without operation is four years; but the statistics of Sibley and Von Winiwarter give a period of only from thirty-two to thirty-three months. The average duration of life in cancer of the breast may therefore probably be estimated at about three years. As a general rule, the progress of scirrhus is slower in old people, in whom it occasionally gives rise to a kind of atrophy of the breast, with shrinking of the tumour. There are many instances on record, in which cancer of the breast is said to have existed for a far longer period than this; for ten, twelve, or even twenty-five years, but there must always be a doubt as to the correctness of the diagnosis in such cases.

Pathological Structure.—After removal, scirrhus of the mamma presents considerable variety in appearance. In the majority of instances it occurs as a peculiarly hard, knobbed, and irregular mass, creaking under the knife, when cut, and presenting on section a greyish or bluish-grey, semi-transparent surface, traversed in various directions by bands of a more opaque character, and exuding on pressure a thin milky juice. The section has been very aptly compared to that of an unripe pear. In all slow-growing hard cancers the cut surface becomes distinctly concave, a peculiarity which distinguishes them from all other tumours. In soft cancers this feature is wanting. In many specimens masses of an opaque appearance and yellowish tint may be seen in the midst of the tumour. These are the result of fatty degeneration of the scirrhous structure. In other cases, again, on pressing the tumour, small drops of a thick creamy fluid will appear to exude at various points. This seems to be the inspissated and altered secretion of the gland retained in the ducts. Cysts are occasionally, though rarely, met with in scirrhus of the breast; these are usually small, and contain clear fluid, being deeply imbedded in the substance of the tumour; in other cases they may be large and globular, and filled with a bloody or dark-green liquid. The microscopical characters of scirrhus of the breast are such as are represented in Figs. 396 and 397, Vol. I., pp. 1058, 1059.

Encephaloid.—Formerly, when all soft sarcomata were classed as cancers, encephaloid of the breast was described as a disease of moderately frequent occurrence. Now that the term is strictly limited to the softer and more rapidly growing forms of glandular cancer the disease cannot be said to be common. No sharp line can be drawn between scirrhus and encephaloid; what one Surgeon would term a soft form of scirrhus another would class as encephaloid. Pathologically the difference between the two forms consists in the relative proportion of the stroma and cells. The greater the proportion of stroma, the harder the tumour. In the softer forms the cells are, as a rule, larger. (Fig. 398, Vol. I., p. 1060.)

Soft glandular cancer usually begins deeply in the substance of the breast as a soft globular tumour, which rapidly increases in bulk and infiltrates the whole gland; the integuments covering it are not at first adherent, but are usually pushed before it, and speedily become permeated by a largely ramified network of veins. In some cases I have seen the integuments, early in the disease, œdematous and inflamed, so as to mask the subjacent tumour. The mass at first feels as if composed of several soft and rounded tumours, which may communicate an obscurely fluctuating sensation, perhaps causing the Surgeon to mistake the growth for a cystic formation or an abscess; with which it is especially apt to be confounded in those cases (rare, it is true) in which the skin is inflamed and œdematous. The breast now rapidly assumes a very prominent and conical form; the skin covering it at its most projecting part becomes thinned and reddened, and at last gives way, leaving a large circular ulcer, from which a fungous mass of greyish or reddish-brown colour speedily sprouts up, with a good deal of discharge of a foul, bloody, and offensive character. From this, disintegrated masses are occasionally detached by sloughing. Implication of the glandular structures in the vicinity of the tumour, followed by constitutional cachexy, occurs in this as in scirrhus of the breast, but somewhat earlier. The progress of the disease is always extremely rapid, especially in patients below middle life and otherwise healthy.

Colloid of the breast is of very rare occurrence. Most commonly only a part of the tumour has undergone degeneration, the remainder presenting the ordinary appearances of soft or hard glandular cancer. I have during the last few years removed two very typical specimens of this form of cancer. In both cases the patients were past middle life. The peculiar feature in each case was that though the tumour had implicated the skin and formed a prominence about an inch and a half in diameter and projecting nearly an inch above the surface, no deep ulceration had taken place, nor were the glands affected. A section of the breast showed, in the greater part of the tumour a coarse alveolar structure, the alveoli being distended with colloid matter. The growing margin of the tumour presented the ordinary appearance of a rather soft scirrhous cancer, and between this and the colloid part every intermediate gradation was recognizable. The nature of the growths was confirmed by microscopic examination. The duration of life in colloid cancer is longer than in any other form.

Duct-Cancer. Villous Cancer.—Under these names has been described a rare form of tumour which infiltrates surrounding parts, infects the glands, and generalizes like an ordinary cancer. Its structure has been very fully described by Cornil and Ranvier. To the naked eye it may resemble encephaloid cancer, and its section yields an abundant milky juice, but it differs from ordinary cancer in presenting numerous small cysts, some only just visible to the naked eye, and others an eighth of an inch, or even more in diameter. In some specimens these cysts are filled with blood. Microscopic examination shows it to be composed of a well-formed fibrous stroma, containing spaces lined with an epithelium tending to assume a columnar form. Delicate villous processes covered with epithelium project from this stroma into the spaces. These villi contain loops of capillary vessels which yield the blood so often found filling the spaces. According to Cornil and Ranvier the greater part of the small cysts can be clearly recognized as dilated galactophorous ducts, and they are of opinion that these tumours are malignant growths springing from these structures. As before pointed out, villous growths may form in simple glandular cysts, and these may bear the same relation to villous cancer that the simple papillary polypus of the rectum does to columnar epithelioma. When these tumours affect the lymphatic glands the secondary growths present the same structure as the primary.

Causes of Cancer of the Breast.—These are usually extremely obscure.

Sex is certainly the circumstance that has the most marked influence on the occurrence of mammary cancer, the disease being, as is well known, almost entirely confined to women; yet instances of this affection in the male breast occasionally occur. Its peculiar frequency in the female may possibly be connected with the great and sudden alternations of the functional activity of the breast in women. The changes impressed upon this organ at puberty and during pregnancy, the various alternations which it undergoes, the inflammatory affections to which it is subject during lactation, the frequent irritation to which it is exposed by sympathizing with uterine derangement, and the diminution in its vital activity that takes place at the change of life, are sufficient to explain the great liability of this organ to disease generally; and may not improbably give a clue to the reason why it is peculiarly the seat of cancer in women.

Age.—An analysis of 600 cases observed by Bryant gives the following result: 4 per cent. occurred before 30; 27 per cent. between 30 and 40; 36 per cent. between 40 and 50; 25 per cent. between 50 and 60; 7 per cent. between 60 and 70. Two cases only were over 70. These results correspond almost exactly with an analysis of 642 cases by Gross. The earliest case confirmed by microscopic examination is recorded by Henry of Breslau as occurring in a young woman aged 21. I have removed a scirrhous breast from an unmarried woman 23 years of age, and Bryant has seen it at 25, 26, and 28. In young subjects the tumour is apt to grow rapidly and to assume the form of encephaloid, but most of the recorded cases have been of the scirrhous variety. In elderly women also scirrhus is the prevalent form, though I have seen several instances of encephaloid at an advanced age.

Social Condition.—Bryant states that of the 600 cases observed by himself, 80 per cent. were or had been married; and Gross made the proportion 88 per cent. in his cases. According to the Registrar-General's returns, 84 per cent. of the women in London over 35 years of age are or have been married. It would seem probable, therefore, that cancer occurs proportionally with equal frequency in married and single women. Of the married women in Bryant's cases, no less than 26 per cent. were sterile; while Gross makes the proportion only 16 per cent. Both Bryant and Von Winiwarter observe that a large proportion of the prolific women had borne many children. The menstrual function is persistent at the time the disease appears in 70 per cent. according to Birkett, and 61 per cent. according to Gross.

Injuries inflicted upon the breast, such as blows, squeezes, &c., are commonly referred to, and are greatly dreaded by women, as the causes of cancer That they might be so in constitutions otherwise predisposed to the affection, does not appear improbable; and that they are so in reality in many cases, I have not the least doubt. The number of instances that have fallen under my observation, in which a blow or squeeze of the breast has speedily been followed by the appearance of a cancerous tumour in it, leaves no doubt whatever on my mind of the truth of the popular belief that associates the injury with the disease, in the relation of cause and effect. **Lacteal Inflammations** are likewise frequently supposed to tend to the production of cancer of the breast. Of this doctrine, I think that we do not possess at present sufficient proof; though it appears highly probable that disturbance of the functions of the organ during lactation may predispose to the occurrence of this disease.

Disease of the Nipple, resembling eczema, has been described by Sir James Paget as an occasional precursor of cancer of the breast. The areola in most cases is red, raw, and finely granular, and there is an abundant yellowish discharge, which forms scabs as it dries. It is accompanied by itching. In other cases the condition more nearly resembles psoriasis, the surface being dry and scaly. The disease rarely extends beyond the limits of the areola. Occasionally ulceration takes place by which the whole nipple may be destroyed. When cancer follows this condition, the tumour is usually situated immediately beneath the diseased nipple, but it may be more deeply seated. The disease differs from ordinary eczema in its tendency to scaliness and to ulceration. Butlin and Thin have examined the diseased tissues microscopically. Butlin found proliferation of the deeper layers of the epithelium, and small-cell infiltration of the corium of the areola, dilatation of the galactophorous ducts, with proliferation of their epithelium, sometimes completely choking them, and small-cell infiltration around the diseased ducts. Deeper down, the epithelium of the acini was seen to be proliferating, and finally to be invading the tissues around. There are two ways in which this condition may be explained. The disease of the nipple may be primary, and by extending down the ducts to the acini, may finally determine the development of true cancer in the gland; or it is possible that the primary disease may be in the acini, and that, as a consequence of it, a morbid secretion may exude and irritate the muco-cutaneous surface with which it comes in contact. That the latter explanation is probably sometimes the true one would appear from a case under my notice in which a lady having atrophic scirrhus of the right mamma, became affected by eczema of the left nipple. After a time the axillary glands on this—the left side—became cancerous, and then some induration was detected in the left mamma. Here it seemed probable that the primary disease of the left mamma consisted in a small scirrhous infiltration of it which simultaneously, or almost so, gave rise to eczema of the nipple and glandular infiltration. No treatment has any influence on this condition, and its appearance in a middle-aged woman must excite grave apprehension as to the future development of cancer. Paget has suggested anticipating the development of the tumour by excision of the breast, especially if there is a hereditary tendency to cancer.

The influence of **Heredity** and the **Geographical Distribution of the Disease** have been already sufficiently discussed in the chapter on cancer in general (Vol. I., pp. 1046 and 1049).

Diagnosis.—The diagnosis of cancer of the breast from other diseases affecting this organ is of the first importance, and is attended by corresponding difficulties. The great point is to determine whether the tumour of the breast be of a cancerous character or not; that the Surgeon should go beyond this, matters little in practice—and, indeed, except in some of the forms of cystic disease of this organ, few practitioners would feel disposed to endeavour to carry their diagnosis beyond this point. The great and essential difficulty in determining the nature of a tumour of the breast consists in the fact of the same signs being more or less common to many growths in this region; a hard, circumscribed, indolent mass, chronic in its progress, with a certain amount of pain, being the usual characteristics presented by all solid mammary tumours; and though in nine cases out of ten a tumour presenting these characters, which has existed for a year or more in an elderly woman, and has resisted ordinary absorbent and alterative treatment, is scirrhous, yet instances of the reverse occasionally occur. Nothing can better exemplify the difficulty of diagnosis in tumours of the breast than the circumstance, which is not unfrequently witnessed, that after the removal of the diseased mass, its section, and careful examination, Surgeons of equal experience will differ as to whether it be malignant or not, and to what class of affections it should be referred; and, indeed, in many of these cases it is impossible to ascertain its precise nature without having recourse to microscopical observation.

It is extremely difficult to lay down any definite rules of diagnosis by which the question as to the malignancy of a tumour of the breast can be solved. In the majority of cases of *cystic growth* in this region, there is little difficulty; the existence of cysts of sufficient size to be readily felt or seen through the skin being generally characteristic of the non-malignant cystic growths. It must be borne in mind, however, that cases, such as one to which allusion has already been made, may occur, in which cysts are conjoined with cancer.

The diagnosis between *cystic sarcoma* and some forms of *cystic cancer* of the breast is not always easy; indeed, it may be impracticable except by microscopic examination after removal. I have had in the Hospital a patient fifty-nine years of age, in whose breast a hard tumour, as large as half an orange.

had existed for five years; it was perfectly and freely movable, unconnected in any way with the skin; there was no retraction of the nipple, and no lancinating pain. On its upper side, several large cysts could be felt, and seen through the skin. On examination after removal, it was found to be cystic scirrhus, with large cysts of the size of cherries, containing bloody and yellow fluid. The only very suspicious circumstances here were the age of the patient, and the existence of one small indurated gland in the axilla.

In these cases of doubt, the safer plan is always to make an exploratory puncture, and, if necessary, to examine under the microscope the contents withdrawn by the groove in the needle or by the trochar; indeed, if there be the slightest doubt as to the nature of the tumour, this exploratory puncture should never be omitted before its removal is determined upon. I have more than once seen tumours which had been positively pronounced to be scirrhous, and for which amputation of the breast had been recommended, prove to be cystic, and disappear entirely when their contents were withdrawn.

Between cancer and the *ordinary solid tumours* of the breast, more especially the adenoid and adeno-sarcomatous, the diagnosis is often difficult; but we may arrange the chief signs of the two forms of disease in distinct groups, that, by comparing them together, the differences may be more clearly seen. (*See* Table.)

NON-MALIGNANT TUMOURS.	SCIRRHOUS TUMOURS.
Feel. Moderately hard, nodulated, irregular in shape; occasionally more or less lobed; distinctly circumscribed; sometimes elastic in parts.	*Feel.* Of stony hardness, knobby and indistinctly circumscribed, or somewhat square, and occupying the whole of the substance of the gland.
Mobility. Considerable, though occasionally there is a deep pedunculated attachment.	*Mobility.* At first, considerable, but soon lost from adhesion to the deeper structures by a broad attachment.
Skin. Of the natural colour throughout, though thinned and expanded with the tumour lying close beneath it. Implicated only in the advanced stage of cystic sarcoma.	*Skin.* Early implicated; at first dimpled, then red or purple, and in other cases brawny and leather-like, so that it does not admit of being pinched up into folds; or nodulated; purple-red masses form in it.
Nipple. Usually not retracted.	*Nipple.* Usually retracted.
Veins of the Skin. Not much dilated.	*Veins of the Skin.* Occasionally greatly dilated.
Pain. Often moderate; if severe, continuous or of a neuralgic character, much increased by handling.	*Pain.* Often none at first, and lancinating, especially at night, after handling, and when the skin is implicated, but not continuous.
Axillary Glands. Of usual size. Lymphatics not affected; supraclavicular glands not affected.	*Axillary Glands.* Healthy at first, subsequently enlarged and indurated. Indurated mass of lymphatics under and parallel to edge of the pectoral, stretching into the axilla; supraclavicular glands enlarged in later stages.
Constitutional Infection. None.	*Constitutional Cachexy.* As disease advances.

The co-existence of adenoma and carcinoma in the same breast is exceedingly rare, though a case has been recorded by Rushton Parker. In such a case the diagnosis must necessarily be very obscure.

The diagnosis of cancer of the breast from *chronic interstitial inflammation* of a lobule of the gland is often extremely difficult. Both diseases implicate the mammary tissue, are ill-defined, hard, and often nodular. The pain may be the same in both, and they may occur at the same age. If the inflamed lobule be near the surface the skin may dimple over it as in a cancer, and in rare cases there may be an enlarged gland in the axilla. As a rule, however, the nodule may be felt perhaps in each breast, whereas a primary scirrhus is always single. In the later stages, when cancer has implicated the skin and glands, the difficulty in diagnosis is no longer present.

A similar difficulty often arises in cases of *chronic encysted abscess.* Here the relation of the disease to impregnation and the slight œdema almost always to be recognized over an abscess will show the nature of the disease.

Rapidity of growth, although always a very suspicious circumstance, cannot by itself and without other signs be taken as unequivocal evidence of malignancy. I have seen a so-called "chronic mammary tumour," probably an adeno-sarcoma, increase from the size of a hen's egg to that of the adult head in less than six months.

Recurrence after removal, though a very suspicious circumstance, is by no means a proof of cancer. Rapidly growing sarcomata will recur. This I have seen happen five times in a lady, otherwise in perfect health, and without a trace of general infection of the system (*see* page 763). So also the recurring fibroid tumour has been removed eight or ten times from the breast, before its complete extirpation has been effected.

In cases in which, after carefully applying the foregoing principles of diagnosis, the Surgeon is still uncertain, he may feel tempted to wait until time clears up the doubt and makes the nature of the disease evident. By so doing the only hope of materially prolonging the patient's life, should the disease be really malignant, is lost. In the present day, when our treatment of wounds is so far perfected that a simple incision may be regarded as free from danger and almost free from inconvenience, it is the Surgeon's duty to cut into every doubtful tumour which may by any possibility be a cancer, and to remove a piece for examination. In the great majority of cases the naked eye appearances will at once determine the question whether it be a cancer or not, but should there still be doubt a scraping or a small fragment teased out with needles may be put under a microscope, which should be at hand for the purpose, and it is very rarely indeed that any doubt will then remain. In such cases it is better to obtain the patient's consent to do whatever may be necessary before making the examination, so that no time may be lost and the whole breast immediately excised should it prove to be cancerous.

TREATMENT.—In cases of cancer of the breast, the first question that presents itself to the Surgeon is, whether any plan of treatment short of the removal of the tumour holds out a prospect of cure, or even of relief; and if not, whether the extirpation of the cancerous breast can be undertaken with a prospect of ridding the patient of an otherwise fatal disease, or at least of prolonging her existence. To these questions the remarks made at p. 1068 *et seq.*, Vol. I., on the general treatment of cancer, may be considered applicable. The management of cancer of the breast, however, involves so many special considerations of importance, that it becomes necessary to consider its bearings somewhat in detail.

No constitutional means appear to be of the slightest service in arresting, and still less in removing, cancerous tumours of the breast. The advantages stated to have been derived from the use of arsenic, conium, iron, various preparations of mercury, &c., have not been borne out by experience.

Compression by various means, whether by plasters, as employed by Young; by agaric, as used by Récamier; by the spring-pads of Tanchou; or by the slack air-cushion of Arnott, has been said, not only to be a palliative, but a curative means of treatment in this disease; and cases have been recorded in which the employment of this plan of treatment was stated to have effected a complete cure. But, although I am not prepared to deny that chronic inflammatory indurations in the breast may have become absorbed during the employment of this treatment (and indeed I have had occasion to observe this in my own practice), I think that evidence is altogether wanting to show that an undoubted case of cancer of the breast has ever been cured by this means. Every practical Surgeon well knows that it is impossible to diagnose in many cases with certainty the true nature of a tumour of the breast, and must frequently have witnessed cases in which, after extirpation, the morbid growth has been found to be of a different character from what had been supposed. I am acquainted with at least eight or ten cases in which some of the most experienced Surgeons, both in this country and in Paris, have amputated the breast for supposed scirrhus; when, after removal, it was found simply to have been the seat of a chronic abscess with very dense walls. And with regard to a small hard, chronic, and indolent tumour of the breast, few Surgeons will hazard a positive diagnosis as to whether it is scirrhus or not, until they have actually seen a section of it. For these reasons, it is impossible not to receive with the utmost hesitation the cases of supposed cancer of the breast reported as cured by the advocates of compression.

But, though there is no evidence to prove the utility of compression as a *curative* agent in cancer of the breast, I think that, when practised with Arnott's slack air-cushion, or Tanchou's spring-pad, it is of considerable value as a *palliative* in some of the earlier stages of this disease should the patient refuse to submit to operation; then it may undoubtedly occasionally arrest its progress for a time, diminish the size of the swelling, and lessen the violence of those attacks of lancinating pain which are so distressing to the patient. In conjunction with the pressure, much relief to suffering may be afforded by the use of belladonna plasters, or of atropine or aconite inunctions, together with the internal exhibition of conium and morphia, or hypodermic injections of morphia and atropine.

In the advanced stages of the disease, however, when the skin is involved, the pressure is often unbearable, increasing the pain, and acting as a source of irritation to the patient. In some cases of this kind, in which the slack air-cushion could not be borne, I have seen relief afforded by moderate pressure with thick layers of amadou, supported by an elastic bandage, belladonna or conium in powder being dusted on the innermost layer of amadou. A very thin gutta-percha shield, moulded to the part, may sometimes be advantageously applied over this, and kept on by turns of an elastic roller. When the skin is implicated and very tender, the application of belladonna and lead lotion is of use. When the disease has run into an ulcerated stage, the internal administration of conium, so as to blunt the sensibility, and the local application of eucalyptus oil and iodoform ointment, boracic acid lotion, and solution of permanganate of potash, to lessen the fetor, together with the watery extract of opium or of belladonna, or an ointment containing cocaine, will relieve. The employment of the various antiseptic dressings that are familiar to all Surgeons is of much service in the advanced stages of ulcerated cancer of the breast, removing fetor, and lessening the inflammatory irritation occasioned by the decomposition of the discharges.

Caustics, applied in accordance with the principles laid down at p. 1070, Vol. I., may occasionally be advantageously employed in the treatment of cancer of the breast, or when the patient is alarmed at and positively refuses to submit to the knife.

Operation.—The constitutional and ordinary local treatment of cancer of the breast being thus, at the most, of a palliative character, the question of operation always presents itself at last. The objects proposed are, in the first place, by the extirpation of the diseased breast, to prevent constitutional infection, and thus permanently to free the patient from her otherwise necessarily fatal affection ; or, failing in this, to retard the progress of the constitutional infection, and thus at least to prolong existence. How far these objects are attained by amputation of the cancerous breast is a subject of important inquiry to the Surgeon. The operation has been discountenanced by many excellent pathologists ; not so much from any extrinsic danger it may possess, for, although occasionally fatal from erysipelas or some similar accidental complication, there is nothing specially hazardous about it ; nor from its being now, as formerly, open to the objection of subjecting the patient to unnecessary pain, all suffering during its performance being prevented by anæsthetics, and little inconvenience being experienced at subsequent dressings, which are usually almost painless ; but the great objection lies in the fear that the disease will return and run its course as rapidly after the operation as if none had been performed, in some cases perhaps even more rapidly.

The principal points in connection with the operation appear to resolve themselves into two questions :—1. In any case of cancer of the breast, may constitutional infection be prevented by amputation of that organ ; and, if so, under what circumstances will this most probably happen ? 2. Although the disease may eventually return in the part or elsewhere, may not excision arrest the rapidity of the fatal termination ? (*See* p. 1073 *et seq.*, Vol. I.).

To the first question, it is not easy to give a very definite reply. The older statistics upon this point are but of little value, for the following reasons : 1st, that it is only comparatively recently that it has become possible clearly to distinguish, even after removal, the various forms of sarcoma and of inflammatory induration from cancer ; and 2nd, that until even a more recent period most Surgeons have contented themselves with removal of the diseased mamma, leaving the axillary glands untouched, unless they were obviously affected. We may therefore put on one side the statistics of Hill, who states that out of 88 cases, there were only 10 relapses and 2 deaths in those operated on by him at least two years before ; of Alexander Monro, who saw no recurrence in 4 out of 60 ; of Boyer, who saved 1 in 25 ; of Macfarlane, who saved none ; of Warren, who saved 1 in 3 ; and Cooper, 1 in 4.

Gross has collected the records of 519 cases of operation for cancer of the breast. Of this 64 were lost sight of, and of the remaining 455, 90 were alive at the time of the report, but only 47 of these had passed the period of three years which has been somewhat arbitrarily fixed as the time after which recurrence is no longer to be feared. The proportion of cures was, therefore, not less than ten per cent. Butlin, from an analysis of 311 cases came to a very similar conclusion.

Since the introduction of anæsthetics, and more especially since the recent improvements in the treatment of wounds, the more extensive removal of the affected parts has been largely practised by Lister, Banks, Billroth, Küster, Volkmann, Gross, and many others. These Surgeons advocate the removal of the entire mamma, with as much of the skin covering it as can conveniently be taken away, together with the axillary glands, even when these are not obviously affected. The results obtained so far by this treatment have been most encouraging. Thus Banks has published the records of 46 cases, ten of whom were alive and free from recurrence at periods varying from two to ten years after the operation, and in five more no recurrence had taken place from one to two years after the operation. Küster states, that in 26 per cent. of the patients operated on by him, no recurrence had taken place three years after the removal of the breast. Billroth states that he had under observation 13 cases, in which no recurrence had taken place within two years of the operation, 5 of which had remained free for four years and upwards, and 4 more for more than three years. In almost all of these the axillary glands had been removed either at the same time as the mamma or in a subsequent operation. These extensive operations under the modern system of treating wounds heal frequently without suppuration. Some stiffness of the arm preventing movements above the level of the shoulder is usually left, but this is of small moment if a greater chance of permanent relief is given.

The inference fairly deducible from these cases is, that in a certain proportion of cases, cancer has been effectually removed by extirpation of the breast, and that the proportion of these cases in the practice of any particular Surgeon is in direct ratio to the freedom with which he removes the diseased structures. There is no doubt, however, that the more extensive operation including the removal of the glands, is accompanied by a higher mortality than the simple amputation of the breast if it be adopted indiscriminately in all cases. It is wiser, therefore, to use some discretion in choosing the cases in which to practise it. If the glands be not obviously diseased and the patient be old, in feeble health, or very fat, it is better not to run the risk of the larger operation. If she be thin and in good health the danger of opening the axilla is so small that there need be no hesitation in removing the glands with the breast. There are no statistics at present of any value showing the relative proportion of cures after the two operations, as the cases in which obvious enlargement of the glands existed, and in which, therefore, the disease was far advanced, have not been separated from those in which the axilla was cleared out merely as a matter of precaution. Of course all cases in which the breast only has been removed may be assumed to be free from obvious glandular complication.

As to the second question—whether as a general rule life may not be prolonged by the performance of the operation,—we are confronted with the same fallacy in all the older statistics. Leroy D'Étiolles, Walshe, Cooper, and Brodie, were all of the opinion that life was little if at all prolonged by operation; and although Velpeau, Callaway, Brodie, and other Surgeons recorded cases in which the patient had lived many years after the operation, most of them were probably cases of sarcoma.

The most trustworthy statistics that we possess on the relative duration of life in cases of cancer of the breast, with or without operation are those collected by Sir James Paget, Morrant Baker, and Sibley; but even these probably include some cases of sarcoma under the name of encephaloid cancer. Paget states that, of 113 cases, 66 were not submitted to operation; of these the average duration of life was a little more than 48 months. Of 47 operated on, the corresponding average was also a little more than 49 months. In the first two years of the disease the proportion of deaths was much less in those operated on than in those who were left—being in the former 24 per cent., in the latter 36 per cent. The longest duration of life in cases not operated on was 18 years; in those operated on, a little more than 12 years. Morrant Baker finds that in 84 cases in which no operation was performed, the average duration of life was 43 months; in 62 cases operated on, the average was 56½ months. Sibley finds that the average duration of life in cases not operated on was about 32 months; whilst in those subjected to amputation of the breast it reached 54 months. Thus it will be seen that, independently of the possible chances of a complete cure, the operation holds out the prospect of an average gain of about a year and a half.

There is, however, another point of view from which these operations may be considered; for, even if they do not prolong life, they may greatly improve the patient's condition, and place her in a state of comparative comfort during the remainder of her existence. Thus, she may be suffering so much pain from the local affection, or, if the cancer be ulcerated, may be so much annoyed by the fœtor of the discharges, that she may be placed in a position of far greater comfort by having the local source of disease and irritation removed; and though she die eventually of cancer, being carried off by cachexy with secondary growths in the lungs or liver, it will be with much less suffering to herself and others than if she were worn out by the pain, discharge, and hæmorrhages, of a slowly progressive ulcerating cancerous mamma.

The question as to the advisability of operation in any given case of cancer of the breast cannot, however, be determined by abstract pathological reasoning, by reference to scientific principles, or by calculations founded on statistical results. Whatever the value of statistics may be in determining the question, whether in cases of cancer of the breast generally the operation will effect a cure or prolong life, they are not equally valuable in their application to individual cases. When a Surgeon is called on for his opinion respecting the propriety of amputating the breast of the patient before him, it is not sufficient for him to be able to state what the general result of the operation may be, but he must be able to satisfy himself whether the particular instance under consideration may or may not be one of those cases in which there is a possibility of extirpating the disease entirely from the system, or at all events of prolonging the patient's existence. In order to do this, it is necessary to endeavour to lay down some rules that may guide us in selecting those cases in which the operation may be advantageously done, and in setting aside others in which we know that it will almost to a certainty hasten the patient's death. And, indeed, it is the absence of all such considerations in general statistical investigations into the results of operation for cancer, that deprives them of their value as guides in actual practice.

Though nothing can be more unsurgical and improper than the indiscriminate extirpation of cancerous tumours of the breast from all patients who may present themselves in whatever stage of the disease ; and though such a practice would doubtless be followed by results fully as disastrous as those that occurred to Macfarlane, Boyer, and others ; yet there can be little doubt that a Surgeon who would employ a certain principle of selection would obtain a very different and a far more successful result in his practice. Sir B. Brodie very clearly and succinctly pointed out the most important circumstances by which the question as to the propriety of operating in these cases should be determined. Before doing so, he very justly dwells on the fact that in many cases the operation may fail, and the disease speedily recur, through the negligence of the Surgeon in leaving portions of the gland, or contaminated tissues, and that thus the operation may receive discredit for what is in reality the fault of the Surgeon who has performed it.

With reference to operation, cancerous diseases of the breast may be divided into three classes :—1. Those in which it is the duty of the Surgeon to discountenance excision ; 2. Those in which the operation is of doubtful expediency ; and 3. Those in which it is the duty of the Surgeon to recommend it.

1. **Cases unfit for Operation.**—This class includes cases presenting the following conditions : *a.* Strongly marked constitutional cachexy ; *b.* Disease in both breasts ; *c.* Secondary deposits in internal organs ; *d.* Much enlargement of the glands under, and especially of those above, the clavicle ; *e.* Œdema of the hand and arm from pressure on the axillary vein ; *f.* Adhesion of the tumour to the ribs and intercostal muscles ; *g.* Hard, brawny, and infiltrated skin, of a reddish-brown colour, having a hard, leathery feel, or a greasy, glazed appearance ; *h.* Rapid growth of the tumour in a patient with a strong hereditary taint ; *i.* An extensively ulcerated and fungating tumour, with marked constitutional cachexy.

2. **Doubtful Cases.**—*a.* If the patient be aged, weak, anæmic, or very fat, and the tumour large, it is seldom expedient to operate, as the shock may destroy life. *b.* When the skin is merely dimpled in by a kind of pedicle passing from the tumour to its under surface, an operation may be performed, unless other circumstances should contraindicate it ; but in such cases it is necessary widely to excise the integument surrounding the attached point. The cancer-cells, as I have more than once had occasion to observe, will have diffused themselves extensively through the neighbouring skin, which, to the naked eye and to the touch, has a perfectly healthy appearance, the tumour being surrounded by a kind of halo of cancer-infiltration. *c.* When there is but moderate enlargement of axillary glands, which are so situated as to admit of removal, the operation may be performed. *d.* When the cancer is ulcerated, it is seldom proper to operate ; but, if all other conditions be favourable, even this need not in some special cases be a bar. As Sir B. Brodie has pointed out, the patient's existence may sometimes in these cases be prolonged, and her comfort increased, by removing the ulcerated mass.

Old age exercises a material influence on the expediency of operating for cancer of the breast. As a rule, I do not think it advisable to do so after seventy years of age, unless the distress from pain or the discomfort from fetid ulceration be so great as to render removal at any risk justifiable. The danger of the operation is greatly increased by advanced age, more especially if the patient is stout ; and if recovery take place the expectancy of life after seventy would not be materially, if at all, increased by the extirpation of a disease which would probably recur and prove fatal within two years; the more so, as the progress of cancer in advanced age is often very slow.

Pregnancy is not necessarily a bar to the performance of any necessary operation, even of amputation, on the female breast. In pregnant women cancer when attacking the breast becomes very active, hence its removal should not be too long delayed, if all other circumstances are favourable. Should, however, the sixth or seventh month be reached, it might be as well to delay the operation till after recovery from parturition. But in deciding this question much will depend not only on the rapidity of the growth of the tumour, but on the size of the breast and the moral effect of the operation.

3. **Cases favourable for Operation.**—All cases of cancer of the breast are favourable for operation when recognized sufficiently early, provided the patient is suffering from no constitutional disease, but unfortunately, either from reticence on the part of the patient or hesitation on the part of the medical attendant, the question of operation is frequently not raised until some of the unfavourable conditions already mentioned have appeared. The exclusion of all the cases in which this has happened will necessarily limit very materially those in which an operation may be undertaken; it can, however, be performed with every prospect of its being advantageous to the patient, if the tumour be of moderate size, slow or nearly stationary in its growth, unconnected with or at least merely attached by a pedicle of the skin, pretty distinctly circumscribed, movable on the subjacent parts, and not complicated by greatly enlarged glands in the axilla or elsewhere. The patient has an especially good prospect of recovery, according to Brodie, if the disease be seated in the nipple.

When once a tumour of the breast has been ascertained to be of cancerous character, the sooner it is removed the better, unless one of the special reasons adverse to operation that have just been mentioned should exist. Every day's delay diminishes the chance of permanently relieving the patient. The disease (for reasons stated at p. 1051, Vol. I.) appears in the early stages often to be entirely local: there is no evidence of constitutional infection, but if the operation be delayed the skin speedily becomes implicated, the axillary glands enlarge, and cancerous cachexy sets in. In all cases of cancer of the breast the whole of that organ ought to be freely removed, especial care being taken that no bits of mammary structure be left behind; and after removal the under surface and edges of the gland ought to be carefully examined, to discover whether the extirpation has been complete. The question of the simultaneous removal of the axillary glands in every case is still an open one, but when we consider how unsatisfactory the simple excision of the gland usually is, it certainly deserves a trial. When the cancer is infiltrated, the whole of the breast and the surrounding cellulo-adipose structures must be very freely removed, as there is often a halo of cancerous infiltration around the morbid mass, in tissues apparently healthy. It may happen that the tumour, especially if scirrhous, is apparently isolated, and situated at one border of the gland, scarcely, if at all, connected with that structure. Here the question will arise, as to whether the whole of the organ ought to be removed or not. In determining this we must, I think, be guided by the position of the schirrous mass and the size of the breast. The cancer-infiltration proceeds in the course of the lymphatic vessels. If the cancer be situated towards the sternal or under aspect, however isolated it may appear, it will be found that the mammary gland will certainly have become infiltrated, lying as it does between the morbid mass and the lymphatics. When, however, the tumour is seated at the upper or outer border of the gland; when it appears to be detached from the breast, lying rather in the axilla or below the clavicle than in connection with the gland; when the breast itself is very large and fat, but healthy to the feel, without hardness or retraction of the nipple; when there is no sign whatever of deep infiltration—it may then be a question whether it will not be more prudent to extirpate the tumour alone, with the adipose bed in which it lies, and a deep slice of the adjoining mammary gland, than to perform the more serious operation of removing the whole of the breast. In determining this point we must, I think, be guided by the situation of the tumour, the feel of the breast, and the size of that organ. If the tumour be distinctly axillary, if the breast feel perfectly soft and healthy, and the nipple project, there is no reason to fear infiltration by cancer of the central and sternal portions of the mammary gland. I have found on careful microscopical examination of breasts removed for scirrhus at the axillary border, that the above-named parts of the gland were entirely free from all sign of disease. If the mamma be small and shrunken, the whole may be removed without any increase of danger; if it be very large, the Surgeon best consults the patient's safety by simply removing the tumour with a deep wedge-shaped piece of the contiguous portion of the gland; but if there be any hardness or suspicious nodulated feel about the mammary gland, if the line of demarcation between it and the tumour be not defined, and particularly if the patient be thin, so that the operation is not a very severe one, extirpation of the whole of the breast ought certainly to be practised. However widely the parts are removed, the line of incision usually comes together readily, owing to the laxity of the integuments in the mammary region.

I have observed in those cases in which it becomes necessary to extirpate tumours of the mammary region, without removal of the gland, that erysipelas has more frequently followed the operation than when the gland, being affected, has required removal.

Return of Cancer after Operation may take place in three situations: in the cicatrix of the part operated upon; in the neighbouring lymphatic glands; or in some internal organ or distant part. When cancer recurs in the neighbourhood of the previously affected part, it is probably owing to the cancer-cells having become widely disseminated in the skin, the subcutaneous areolar tissue and muscles, or neighbouring lymphatic glands, and after the removal of the tumour these cells become the germs of new growths. In these circumstances it may recur in the cicatrix and then implicate the glands; or in the glands without the cicatrix having been previously affected. In local relapse of this kind, it often happens that the disease, so reproduced, runs its course more rapidly than if no operation had been performed; the hyperæmia set up in the part during the healing process appearing to give augmented energy to the cancerous growth. In some cases it returns in the wound even before cicatrization is completed, the surface then assuming the ordinary character of the cancerous ulcer. In other cases, the cicatrix, some weeks or months after it is fully formed, assumes a dusky red or purplish tinge, becoming hard, stony and nodulated at points; these nodules being round or oval, often very numerous, and varying in size from a pin's head to a pigeon's egg, studding the whole length and breadth of the cicatrix, and at last running into ulceration. In such circumstances, the only hope of prolonging the patient's life lies in the speedy excision of the whole of the diseased structures, or their extirpation by caustics, provided there be no deep affection of the glands, nor evidence of internal secondary growths. But if the axillary glands be much enlarged, either alone or together with recurrent disease in the cicatrix, or if there be any sign of internal cancer, further operation will be improper.

Amputation of the Breast.—The question of amputation of the breast should always be raised and discussed with more than ordinary regard to the feelings of the patient. A woman looks upon her breast as alike the emblem and the ornament of her womanhood. She shrinks from the idea of its being affected by disease. She suffers acutely in mind when it is invaded by tumour of any kind : the horrid dread of that disease being cancer ever haunts her thoughts, not so much from the fear of the possibly impending operation, but rather from the distress of mind, in many cases amounting to a sense of humiliation, at the idea of the mutilation of which she is about to become the victim.

The operation for the removal of the breast, whether affected with cancer or with other disease, may be performed in the following way. The patient should lie upon a table, with the arm hanging over the side, tied down or held by an assistant. If the tumour be large, and the loss of blood a matter of much consequence, another assistant should compress the subclavian artery on the first rib. The hæmorrhage will, however depend more on the nature than on the size of the tumour. In all cancerous tumours, but especially in the encephaloid, it is considerable, and from many enlarged vessels. In simple tumours, even of very large size, it is often trivial. I have removed a simple tumour of the breast many pounds in weight, and had to tie only one vessel. Indeed, nothing indicates more conclusively the enormous activity of cancerous tumours, and the great drain they must exercise upon the system generally, than the large size and great number of their supplying arteries, compared with those sent to a simple tumour many times larger than the malignant one. In all cases a sufficient number of forcipressure forceps should be at hand, which can be applied to the vessels as they are cut, and left attached until more permanent means of arresting the hæmorrhage can be carried out if necessary.

In amputations of the breast for cancer, there are three principal points that must be attended to : 1. To remove the whole of the gland and the nipple, except under the conditions mentioned on p. 781 ; 2. To remove the skin widely, even when apparently healthy ; 3. To clear out the axilla if there be any glandular enlargement, or even if none is obvious, when the conditions are favourable for so doing.

The operation should always be done with antiseptic precautions. The whole breast, side, and axilla should first be thoroughly washed with carbolic lotion, 1 to 20. The direction of the incision through the integuments is varied by different Surgeons ; some prefer a transverse, others an oblique one. I think that no definite plan should be followed, but the direction of the cut made to vary according to the situation and size of the tumour, and the amount of integument that requires removal. In all cases, the nipple should be included. In ordinary cases, as a general rule, I prefer an oblique incision following the course of the fibres of the great pectoral muscle ; as it enables the Surgeon, if necessary, to extend the cut into the axilla for the removal of enlarged glands, and, after cicatrization, allows the movements of the arm without undue traction. An oblique elliptical incision, of sufficient length, may thus be made, first below, and next above the nipple, so as to include a sufficient quantity of integument (Fig. 794). In some cases, where the skin is somewhat involved, a transverse incision may be made in addition to this, so as to include the affected integument in a triangular manner. The dissection should then be steadily carried down to the pectoral muscle, every bleeding vessel being immediately seized in forcipressure forceps, and the breast removed with the cellular bed in which it lies. When the tumour is of large size, and especially if it be of simple character, this part of the operation may be done very expeditiously by drawing down the mass and touching the areolar tissue with the scalpel, when the whole tumour will peel off the pectoralis major, with the fascia covering the muscle, and can readily be detached. After the removal of the diseased breast, it and the tumour, as well as the whole interior of the wound, must be carefully examined, to ascertain that no slices of morbid tissue have been left behind; if so, they must be freely cut out; and if, as sometimes happens, the growth be rather firmly adherent to the pectoral muscle, a portion of this must also be removed. In taking away slices after removal of the breast, it must be remembered that the skin, owing to its elasticity, has shrunk to some extent, and half an inch cut away then may equal perhaps an inch in its natural state of tension. Thus, more may be removed than is intended, and great difficulty may be found in closing the wound.

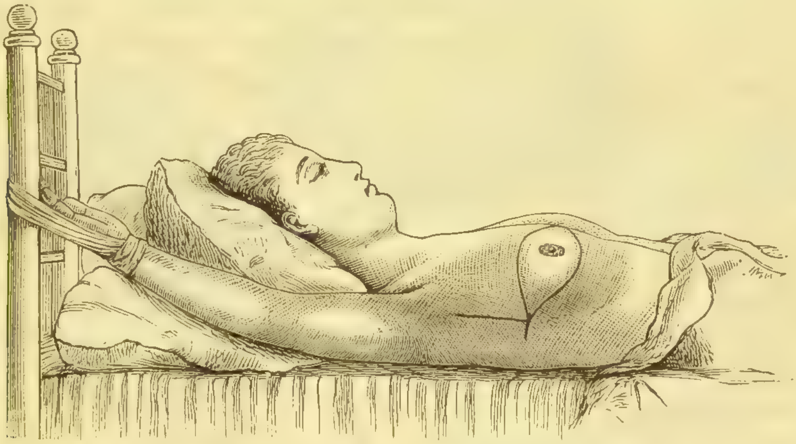


Fig. 794.—Position of Patient in Amputation of Breast.

The clearing out of the axilla adds greatly to the severity and immediate danger of the operation. Should there be enlarged lymphatic glands, or should the Surgeon adopt the course of clearing out the axilla even when diseased glands cannot be felt, this may be done by extending the oblique incision upwards as far as may be necessary. It will often, however, be found more convenient to perform the operation in the following way. An oval incision, the long diameter of which is placed transversely to the trunk, may be made to include the breast, and as much skin as it is intended to remove. From the outer end of this an incision may be carried to the posterior border of the axilla, in the line of the long diameter of the oval incision. Another incision is carried upwards along the anterior border of the axilla to the arm. The mamma is then removed in the ordinary way, the surface of the pectoralis major being carefully cleaned. Having arrested the bleeding, the Surgeon now proceeds to remove the contents of the axilla as completely as possible, including not only the lympthatic glands but the fat surrounding them. While doing this the bandage securing the arm must be loosened, and the limb given to an assistant, who must hold it in the position most convenient to the Surgeon. The edge of the pectoralis major may be cleaned with the scalpel, care being taken to expose and clean the lower part of the pectoralis minor also, as a few glands often lie concealed between this and the great pectoral, and may be easily overlooked. In doing this the external mammary artery will be divided. The contents of the axilla are then turned carefully over to the posterior side of the space. In the lower part this may safely be done with the edge of the knife, but at the upper part the handle of the scalpel and the fingers should be used, and any bands which are met with, and appear to contain vessels, should be isolated, and a ligature passed round them, after which they may be divided with scissors. By thus working carefully at the upper part of the axilla, the fat and the glands contained in it may be safely separated from the great vessels which are left exposed often for one or two inches. Finally, the whole mass is drawn downwards, and separated from the posterior border of the axilla, care being taken not to wound the subscapular artery and vein to which the enlarged glands are sometimes adherent. Should it be necessary to divide these vessels, they must not be cut too close to the main trunks. The complete extirpation of the axillary glands is the most difficult part of the operation, but by patient and careful dissection it can be safely accomplished. If the enlarged glands that are readily perceptible are alone removed without the fat surrounding them, a number of smaller glands are sure to be left behind. Wound of the axillary vein is the most likely accident to occur in removing glands seated high up. It usually arises from tearing through some small branch just as it enters the main trunk. If the opening be very small, it is easily secured by pinching it up, and applying a

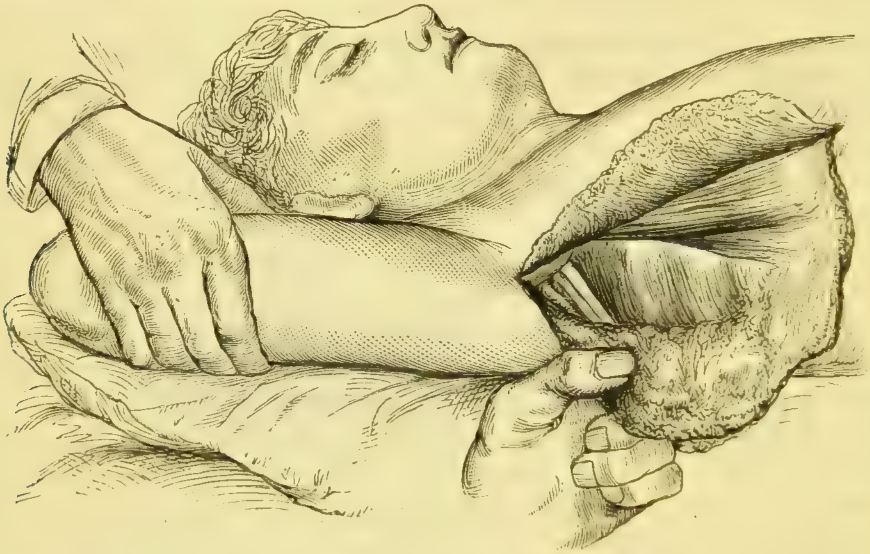


Fig. 795.—Incisions required for thoroughly clearing Axilla.

ligature round it without occluding the whole vein. Should the wound be more extensive, the whole vein should be tied. Billroth states that he has had occasion to do this more than once, and that no evil consequences followed, rarely even œdema of the arm. The safety of the patient depends very much, however, on the successful prevention of decomposition in the wound. Should the injured vessel be bathed in decomposing discharges, the patient would be exposed to the imminent danger of septic thrombosis and pyæmia, which formerly made Surgeons hesitate to apply a ligature to a vein. Entry of air into the vein is a danger which must be borne in mind while removing glands in close proximity to it. It is best avoided by careful dissection, but should the vein be unavoidably in danger, an assistant should place his finger on it, if possible, on the cardiac side of the exposed part. Wound of the artery is much less common. It is most likely to occur from shaving the subscapular branch away so closely as to leave a circular aperture in the side of the main trunk. It can only be avoided by not using sharp instruments in this region. Should it happen, the main trunk must be tied on each side of the wound.

The *dressing* of the wound is of great consequence. A wound that gapes widely whilst the arm hangs down, will be found to close with the greatest ease when the arm is raised and laid across the chest. If properly dressed the patient suffers no pain during the healing of the wound, which is usually complete in about a fortnight; there is no constitutional disturbance of any consequence, and the dressings need not be disturbed more than twice or thrice. Some form of antiseptic dressing should always be applied. The plan that I now usually adopt is as follows: All bleeding points having been secured by torsion or by ligature with fine carbolized catgut, the wound is thoroughly washed out with a solution of chloride of zinc or carbolic lotion. The edges are then to be brought together. If much skin has been removed, and there is considerable strain in approximating them, this should be done by the introduction of one or two deep button-sutures of thick silver wire. The edges are then carefully adjusted, and kept in apposition by means of a sufficient number of points of suture of carbolized silk or catgut. Efficient drainage must next be secured by the insertion of one or two drainage-tubes of good calibre with a piece of silk attached, so that they may not be lost in the wound. If there is a large bag of skin at the axillary border, this may be perforated and one of the tubes drawn through and fixed in the hole. The surface of the wound is then dusted with iodoform, and a large and thick layer of iodoform wool is now to be laid over the wound and well up into the axilla, which must be carefully packed. Over this a still larger and thicker layer of salicylic acid wool must be placed, taking in the shoulder and clavicle.

This dressing should be confined and supported by turns of a body-bandage fixing the arm to the side. It need not be disturbed for several days—a week or more—unless the temperature rises above 100° Fahr., or the discharge from the wound soaks through. The deep silver sutures should be taken out about the eighth or tenth day. The catgut stitches often become absorbed. If not they may be picked out when the wound is healed. After cicatrization is complete the part should be kept covered with cotton-wool for some months, and the patient cautioned not to move the arm too freely. In most cases it will unite by the first intention; for owing to the yielding nature of the parts in this situation, the lips of the cut come into very good apposition, even though a considerable mass has been removed. By some it has been supposed that relapse of cancer is less liable to take place if the wound unite by granulation, than if it come together by more speedy union ; of this, however, there is no proof with which I am acquainted.

The *mortality from amputation of the breast* was never very considerable, and has been greatly reduced by the modern improvements in the treatment of wounds. The circumstances that chiefly influence it are the nature of the tumour, the size of the breast, and the extent of the incision into the axilla. The operation is much more dangerous when performed for the removal of cancerous than of simple tumours : and the danger increases in proportion to the length of time the cancer has been allowed to exist before the operation is undertaken. In proportion as the patient's general health has become undermined by the continuance of the malignant disease, so the tendency to pyæmia and erysipelas increases. Women who have small mammæ, with little fat, bear the operation best. The danger of the operation is, for obvious reasons, much greater in women with large breasts, in whom the areolar tissue is loaded with soft yellow fat. In these reparative action is slow, and there is much tendency to sloughing and to erysipelas. Lastly, the operation becomes dangerous in proportion as the tumour is adherent to the pectoral muscle, and the dissection requires to be carried deeply into the axilla or under the pectoral. The danger here is threefold : 1, from hæmorrhage ; 2, from the entry of air into a vein ; and 3, from opening up the deep fascia of the axilla, and the risk of the occurrence of deep cellulitis. This last danger is much less if the axilla is thoroughly cleaned out than if a small opening only be made in the fascia and the glands torn out through this. It can be much lessened by the proper use of drainage and antiseptic dressings. When death follows these operations it is most commonly the result of erysipelas or septicæmia.

There are two dangers which attend excision of the breast rather more frequently than other operations ; viz., 1st, a congestive form of pneumonia, not dependent on any blood-poisoning, but arising from defective aëration occasioned by the breathing being shallow and restrained either by tight bandaging of the chest, or by the pain induced by the movement of the chest-walls in respiration ; and 2nd, cardiac thrombosis extending into the pulmonary artery. I have known several instances of death from each of these causes. The first danger can obviously be guarded against ; the second cannot.

Axillo-mammary Cancer presents some peculiarities that deserve special consideration. It develops at the outer and upper angle of the mammary gland towards its free border, so that, instead of growing into its substance and remaining imbedded in it, it tends to push in the direction of least resistance to its out-growth, and thus to extend into the areolar space at the lower border of the axillary edge of the pectoralis major, and lie between it and the latissimus dorsi muscle. The tumour feels hard and nodulated, and is rounded in shape. Sometimes it appears to be scarcely attached to the mammary gland. But on closer manipulation it will be found to extend deeply into its substance, which towards the base of the tumour feels hard and thickened. The greater portion of the gland, the median half and much of the lower part, will continue long unaffected by cancerous infiltration. The nipple is not retracted until a very late period in this form of the disease. It and the areola preserve their normal appearances, long after the skin above them has become involved and the axillary glands enlarged. The manner in which the skin is implicated and the appearance it presents are peculiar and characteristic. It becomes involved early by dimpling from below in a transverse direction at the upper and outer border of the mamma, where there is naturally a tendency to a fold or crease in the integument. There the skin becomes infiltrated in a transverse line of hard scirrhus, red, depressed and puckered in, with much feeling of constriction and difficulty in raising the arm from the side. The disease, when once it has reached this stage, will of course make rapid progress both locally and constitutionally.

That these axillo-mammary cancers arise primarily in the breast-gland there can be no doubt, although their rapid development beyond its limits may, at first, lead to the suspicion that they have commenced outside it.

It is only towards the upper and outer border of the mamma that these outgrowing cancers seem to develop. I have never seem them at the inner or lower part of the gland, unless the whole of its structure had been previously infiltrated. The operation in these cases should be complete and thorough, the whole organ being removed, however healthy the nipple, areola, and some portions of its gland-structure may appear to be. The skin also should be widely removed where implicated, and the dissection carried as high into the axilla as can safely be done. Unless thorough extirpation be practised, speedy and rapid recurrence will ensue.

DISEASES OF THE MALE BREAST.

The **Male Breast**, though rarely the seat of disease, may occasionally become affected in a somewhat similar manner to the mammary gland of the female. Cases have been recorded in which it was *hypertrophied*, and in others it has been the seat of an *abnormal secretion of milk*. In boys about the age

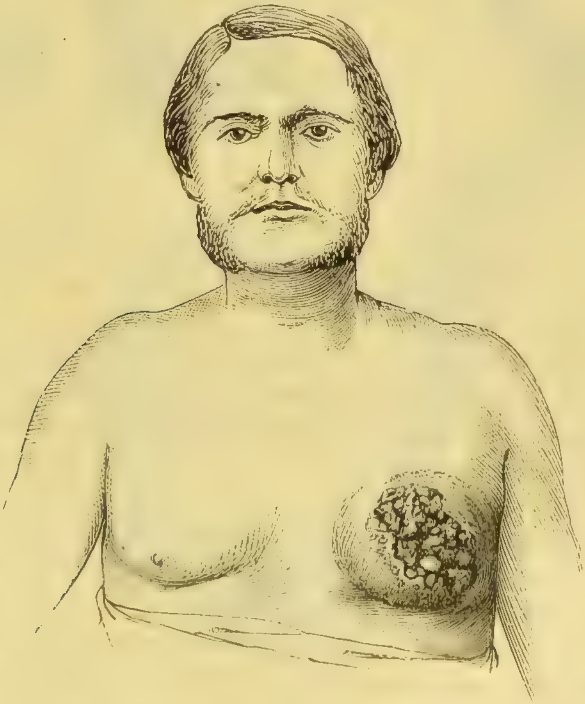


Fig. 796.—Scirrhous Cancer of the Male Breast.

of puberty it occasionally becomes the seat of *subacute inflammation* often attributed to a blow. This is best treated by the application of a belladonna plaster spread on soft leather with a hole cut through it for the nipple. *Chronic interstitial inflammation*, with enlargement and induration of the rudimentary mamma, is occasionally met with, and if a source of much annoyance may justify the removal of the diseased gland. *Cysts and sarcomata* are more rare. *Scirrhous cancer* is occasionally met with. The accompanying drawing (Fig. 796) represents a case of this kind under the care of C. Heath. Those growths require removal by the same kind of procedure that is adopted when they affect the female breast.

AXILLARY TUMOURS.

Chronic Strumous Disease of the axillary glands is occasionally met with, forming a large lobed mass under the pectoral muscle. Such a tumour as this may be easily and safely enucleated, and should be removed if it have resisted all ordinary topical and constitutional treatment.

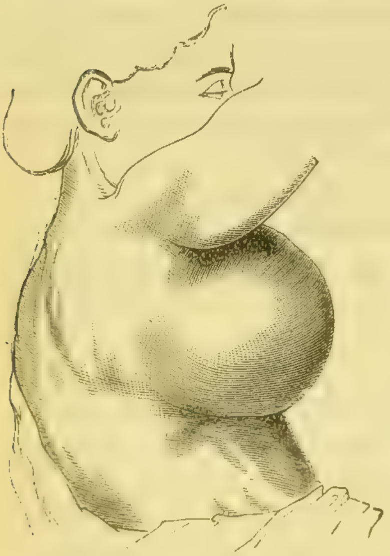


Fig. 797.—Fibrous Tumour in Axilla of a Woman.

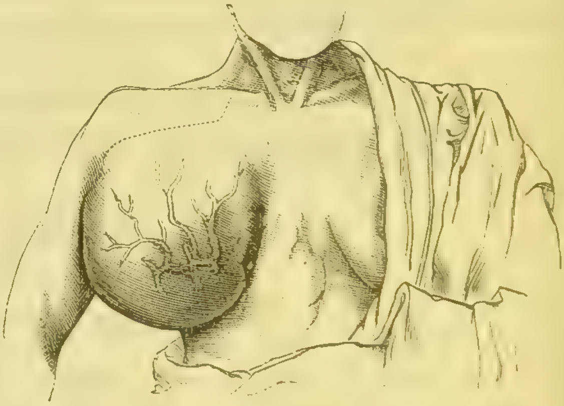


Fig. 798.—Same Tumour, Front View.

Simple Tumours of various kinds are met with in the axilla. The most common are lymphadenomata of the axillary glands, fatty and fibrous tumours.

Lymphadenoma of the Axillary Glands is met with chiefly in young women, forming a smooth, lobed mass, often reaching a great size. It is usually associated with similar tumours elsewhere, but occasionally the glands of the axilla are alone affected. The enlarged glands form no attachments to surrounding parts, and may be readily removed by enucleation.

Fibromata are sometimes met with in this region, and may attain a great magnitude. A fibroma forms a large, smooth, rounded mass, stretching the muscles and displacing the vessels and nerves, as in Figs. 797 and 798. In this case the tumour, which was of very slow growth, developed between the serratus and the ribs, stretching the muscle over it so as to form a species of capsule to it, drawing the scapula forwards, depressing the chest-wall, and drawing the axillary vessels down to about three inches below the clavicle. In removing it I was obliged to take away a piece of the stretched serratus as large as the hand. The patient made an excellent recovery, and experienced no difficulty in breathing afterwards.

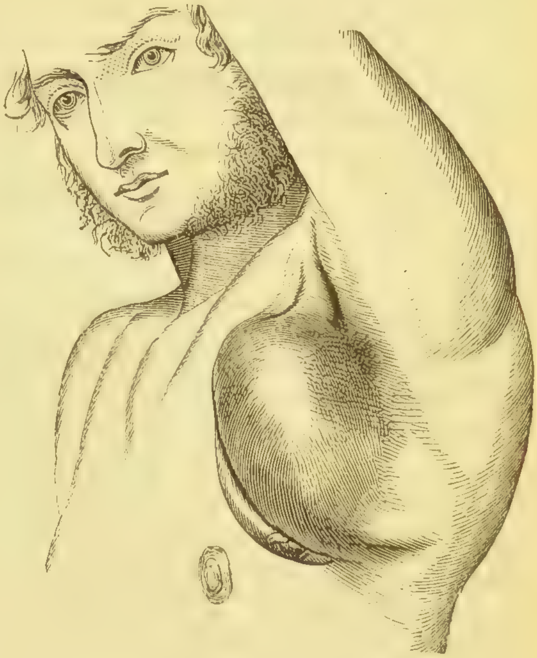


Fig. 799.—Sarcoma in Axilla of a Man.

SARCOMATA of various kinds are met with in the axilla (Figs. 799, 800). Such tumours might, in their early stages, be dissected out; but if they extend high up to the clavicle, or implicate the skin widely by infiltration, they should, I think, be left, as was necessary in the patient from whom Fig. 800 was taken, where the size of the tumour and its connections precluded the possibility of operation. Their removal cannot, indeed, at any stage, be undertaken without much danger. In dissections requisite for the extirpation of such masses, as in Fig. 799, I have had to expose the axillary and subscapular vessels and their accompanying nerves. The growth being usually somewhat widely disseminated, it is difficult to be certain that the whole is fairly extirpated : hence, recurrence is likely speedily to take place.

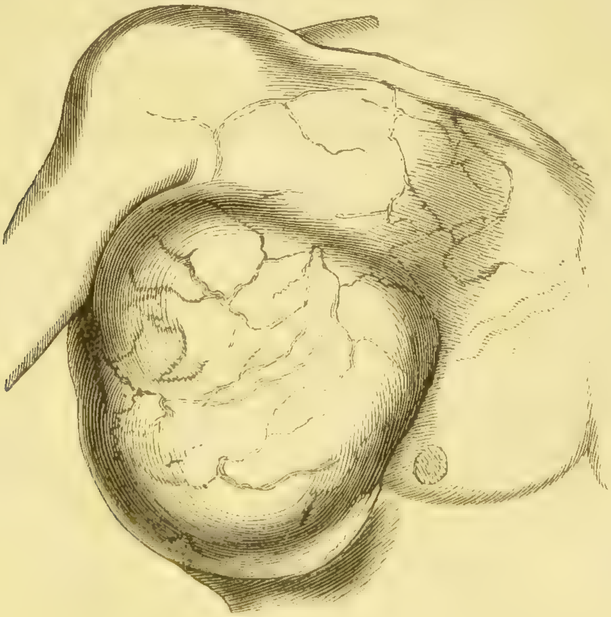


Fig. 800.—Large Sarcoma in Axilla of a Man.

DISEASES OF THE ABDOMEN.

CHAPTER LXI.

In no department of Surgery has there been a greater advance during the last few years than in the **Operative Treatment of Diseases of the Abdominal and Pelvic Viscera.** But a few years ago a wound of the peritoneum, whether accidental or intentional, was regarded as being inevitably accompanied by grave danger to life. The perfection of the operation of ovariotomy, with which the name of Sir Spencer Wells must ever be inseparably associated, led to a more thorough understanding of the causes of death, and established the principles which alone can guide us to success in operative procedures affecting the peritoneal cavity. The systematic use of antiseptics further put at our command the best means of preventing the most common and most fatal complications of peritoneal wounds, so that at the present time operations on the abdominal viscera are undertaken with little more hesitation, and are attended by as good results, as those of equal magnitude in any other part of the body. Before proceeding to the description of the surgical diseases of the abdomen and their treatment, it will be well to consider briefly the special dangers common to all abdominal operations, and the principles which guide us in avoiding them.

Operations on the abdominal cavity, with wound of the peritoneum, should they prove fatal, usually do so from one of three causes—septic peritonitis and septicæmia, shock, or hæmorrhage.

Septic or Diffuse Peritonitis and Septicæmia.—These conditions are so closely associated that it is most convenient to consider them together. Until recently the peritoneum was believed to possess some peculiar tendency to inflammation which rendered a wound of it specially dangerous; the inflammation spreading, as was said, by continuity of tissue. There is nothing to justify such an assumption. The peritoneum becomes inflamed under the same conditions as other tissues, the process is the same, and, as in other parts, it is limited to the area upon which the cause is acting. In the prevention of peritonitis it is necessary, therefore, to consider the causes to which it is due, with a view of excluding them, if possible.

Certain causes of inflammation, as pointed out in the chapter on the Process of Inflammation (Vol. I.) are, from their nature, limited in action. To these belong mechanical injuries, heat and cold, and the action of those chemical substances which cannot increase in quantity in the living body, such as mineral acids, saline caustics, and the like. A wound of the peritoneum, therefore, gives rise to inflammation limited to the area injured, and unless some other cause be introduced it has no tendency to spread further. In inflammation of the peritoneum, as in all other membranes lining cavities, the inflammatory products find their way readily to the surface. If the process be of sufficient intensity an abundant coagulable exudation takes place; the fibrin entangling white corpuscles forms a layer of "lymph" on the inflamed surface, and the serum drains away into the peritoneal cavity. The peritoneum from its intimate connection with the lymphatic system, is possessed of the power of absorption in the highest degree. The serum poured out at the seat of inflammation is therefore absorbed with great rapidity by the healthy part of the membrane, and unless the quantity be very considerable the cavity is kept dry. The experiments by which this extraordinary absorbing power of the peritoneum has been demonstrated have been already alluded to, Vol. I., p. 883. The coagulable exudation which covers the inflamed surface glues it to any contiguous layer of peritoneum, and adhesions are thus formed which subsequently become vascularized and undergo development into connective tissue by processes identical to those occurring in the formation of fibrous tissue in the union of the wound. It is by this process that adhesions form between inflamed coils of intestine, and that ligatures, sutures, and other simple foreign bodies become buried and encapsuled. It forms an essential part of the union of all wounds of the peritoneum, and is often the means of saving the patient's life by preventing perforation of the hollow viscera, or the rupture of collections of pus into the cavity of the abdomen. It is the object of the Surgeon to exclude all those sources of irritation which can convert this simple localized inflammation into a diffuse or spreading process.

The causes of spreading inflammations, as already pointed out (Vol. I., p. 177), are the chemical products of fermentative processes taking place in the normal fluids of the body, or in inflammatory exudations or other collections of fluid. Without again entering into the evidence for and against the theory that these processes are directly dependent upon the presence of microscopic organisms, upon which the antiseptic treatment is founded, we may adopt it as a hypothesis to explain the phenomena of septic peritonitis, and to guide us in the prevention of this fatal complication. It will be remembered that according to this theory two classes of micro-organisms exist, the pathogenic or specific organisms which can infect and multiply in the living tissues and blood, and the non-pathogenic or septic, which grow only in dead matter, and are believed to be the cause of ordinary putrefactive changes. The former we may exclude from consideration here for the sake of simplicity, although it is possible they may take a part in the causation of some cases of diffuse peritonitis.

For the development of septic processes in the peritoneum two conditions are necessary; first, the presence of the putrescible matter, and secondly, the contact of the organisms with it. The putrescible matter is furnished by the liquid part of the inflammatory exudation, or by extravasated blood. The organisms may reach it either from the external wound, carried in by the Surgeon's hands, the sponges, the ligatures, or by the air; or in those cases in which the gut is injured, as in strangulated hernia, they may find their way from the interior of the intestine through the diseased coats. If the amount of the inflammatory exudation be comparatively small it is so rapidly absorbed by the healthy part of the peritoneum that no decomposition takes place, the first condition of the process being wanting. If the amount of exudation be in excess of that which can be at once absorbed, an accumulation takes place, which, if the cause of putrefaction have been admitted to it, speedily decomposes. The irritating products of decomposition become widely diffused, exciting inflammation wherever they go, and thus the whole peritoneum becomes affected. At the same time there is intense poisoning from the absorption of the chemical products of the process. In fact, in a large proportion of cases, this is the immediate cause of death, and may prove fatal before the local signs of peritonitis become very marked. The symptoms are those already described (Vol. I., p. 972) of acute septic poisoning.

It does not always happen that diffuse peritonitis occurs when the opening in the membrane communicates with a foul wound. Thus congested omentum in the operation for strangulated hernia was formerly ligatured with a piece of whipcord, the mass being cut off and the stump and ligature left lying in an open wound to which a poultice was applied. Under these circumstances septic suppuration necessarily occurred, but diffuse peritonitis by no means invariably followed. In those cases there was a free exit for the discharge from the wound and the opening into the peritoneal cavity became sealed by firm inflammatory exudation in the first few hours before decomposition commenced in discharges, and thus the danger was averted. This is, however, an uncertain barrier, and these exceptional cases do not justify us in neglecting any precaution by which the close contact of septic pus with the peritoneum can be avoided.

The prevention of septic peritonitis and its consequences is carried out on two principles ; first, by the use of antiseptics in such a way as to exclude any living organisms from the cavity, and secondly, by draining the cavity in all those cases in which an amount of exudation is expected beyond that which will be immediately re-absorbed. Considerable difference of opinion exists as to the relative value of these methods, some Surgeons maintaining that if antiseptics are properly used drainage is scarcely ever required ; and others that, if the peritoneal cavity be thoroughly cleansed before closing the wound, and drainage be efficiently employed if necessary, antiseptic applications are scarcely required. It is not the place here to discuss this disputed point. The great majority of Surgeons are agreed upon the value of antiseptics to a certain point, the use of the carbolic spray being the matter chiefly in dispute. Its opponents maintain that it increases the shock by chilling the patient, that when the peritoneal cavity is widely open there is considerable danger of carbolic acid poisoning, and that with careful attention to other antiseptic details it may be safely dispensed with. Its advocates maintain that by careful management the chilling of the body and the entrance of a dangerous amount of carbolic acid into the peritoneum are easily avoided, and that by its use they are able to dispense with drainage—which, to say the least, is an inconvenience—save in a few exceptional cases. The point must still be considered an open one, as excellent results have been shown both by those who use the spray and those who do not. In those cases in which but a small opening is made into the peritoneum, and it is consequently impossible to clean the cavity before closing the wound, and in which moreover drainage cannot be efficiently carried out, as in operations for hernia, there can be no objection to using the spray, especially in hospital practice.

Parotitis is a somewhat frequent sequence of operations on the abdominal or pelvic viscera, a fact for which it is difficult to suggest any reasonable explanation (see p. 586).

Shock is a common cause of death in operations upon the abdominal viscera. It probably arises chiefly from the injury done to the large sympathetic plexuses in connection with these parts. The exposure of the viscera to cold and the loss of blood doubtless aggravate it in many cases.

Hæmorrhage is necessarily a source of danger in many cases, but it presents nothing requiring special consideration.

The following *are the general rules applicable to all abdominal operations:* —

1. The room in which the operation is to be performed must not be too cold, especially if the abdominal cavity is to be widely opened and the viscera exposed.

2. In those cases in which it is possible to do so, the bowels should be thoroughly emptied by a purgative the night before, and an enema on the day of the operation.

3. In all operations on the lower half of the abdomen the bladder should be emptied by a catheter immediately before commencing.

4. The patient when placed upon the table should be warmly wrapped up, lest the shock be increased by chilling the body. If the spray is to be used, the body must be covered with a mackintosh cloth, or a sheet of oiled silk with a hole cut in it through which the region of the operation is exposed. The under surface of this may be spread with adhesive plaster for one inch round the aperture to keep it in position.

5. The instruments and sponges, &c., and the hands of the Surgeon and his assistants must be cleaned and disinfected with carbolic acid, as already described (Vol. I. 317). During the operation all sponges must be squeezed as dry as possible, a twisted towel being used if necessary, lest a dangerous amount of the antiseptic be introduced into the peritoneal cavity. They should be washed in warm carbolic lotion to avoid chilling the parts.

6. The sponges should be counted before and after any operation in which they are used inside the abdominal cavity.

7. All hæmorrhage from the abdominal wall must be arrested before the peritoneum is opened.

8. If during the operation the intestines are exposed, they should be held on one side, and retained in the abdominal cavity by a large flat sponge squeezed as dry as possible after having been well carbolized. Should they be exposed externally, as in operations for hernia, intussusception, &c., or escape from the abdomen, they must be covered with a linen rag several folds thick, wrung out of a warm 1 in 40 solution of carbolic acid.

9. When the operation is completed, if the abdominal cavity have been opened sufficiently to admit the hand, it may be cleaned with sponges squeezed as dry as possible and passed into the most dependent parts of the cavity, one after another, until they return quite clean. If there is blood or pus in the cavity, or if fæces or urine have been extravasated, large quantities of a warm solution of boracic acid (1 in 50) may be poured in and emptied out repeatedly till it returns clean, after which the peritoneum may be carefully dried with sponges, if necessary. Cleaning the peritoneum is a most important part of the operation, and success in many cases depends to a great extent upon the thoroughness with which it is done.

10. In closing the wound, the deep stitches, which should be of carbolized silk, must include the peritoneum, so that the serous surfaces shall be brought closely in contact. The importance of this in securing primary union was

demonstrated experimentally many years ago by Sir Spencer Wells. When the abdominal walls are very lax, as after the removal of a large tumour, the stitches may be made to catch the peritoneum, the aponeurosis or sheath of the muscles, and the skin and subcutaneous tissue, missing the muscular fibres ; but if there is likely to be considerable strain, it is better to pass the deep stitches completely through the abdominal wall about three-quarters of an inch from the edge of the wound. Both ends of the deep stitches must be passed from within the abdomen to avoid any risk of puncturing the intestine. All the deep stitches must be passed before any are tightened, and care must be taken while this is being done not accidentally to include a knuckle of intestine between the edges of the wound or under a stitch. After the wound has been brought together, finer stitches may be put in to bring the edge of the skin accurately in contact.

11. If it be thought necessary to drain the abdomen, this is done by a large tube of india-rubber or glass passed into the most dependent part of the cavity and brought out at the lowest angle of the wound. The tube must be of such size that all fluid shall escape readily from it. Inefficient drainage is worse than none at all.

12. The dressing should be composed of some efficient antiseptic material. If the wound is completely closed, a thin layer of dressing is sufficient. If it be drained, a thicker mass must be applied to absorb the discharge. In operations involving the anterior wall of the abdomen, the dressing is most conveniently kept in place by a broad band of strapping, which at the same time supports the abdomen.

13. After most abdominal operations the patient should be kept without food for from twenty-four to forty-eight hours, or in some cases even longer. A small quantity of iced soda-water or barley-water may be given to allay thirst. If the condition of the patient makes it necessary to give food, chicken-broth or iced milk and soda-water is the best, given in small quantities at intervals of about two hours. Small nutritive enemata are often useful. In operations involving the intestine, opium is often necessary to prevent peristaltic movement.

14. If the operation is followed by a high temperature due to absorption of inflammatory exudation from the peritoneum, an ice-cap may be applied to the head as recommended by Knowsley Thornton. If there is reason to believe that the peritoneum is becoming distended with fluid, the patient may sometimes be saved by opening one end of the wound and inserting a tube in those cases in which drainage has not been adopted from the first.

In all abdominal operations success will greatly depend on minute attention to details. The operation must be carefully considered and planned beforehand, and everything that can possibly be required must be at hand. At the end of a severe operation in this region, the patient is often suffering greatly from shock, perhaps hovering between life and death, and a little needless delay from not having everything ready the moment it is wanted, an unnecessary exposure of the intestines for want of a proper flat sponge to retain them, or a failure in some other minor detail, may just turn the scale against him.

HERNIA.

By **Hernia**, in its widest sense, is meant the displacement of an organ from the cavity in which it is naturally contained, by being protruded through an abnormal or accidental opening in its walls; when, however, it escapes through one of the natural outlets of the part, it is not considered hernial. Thus, the protrusion of the brain through an aperture in the cranium, or of the lung through one in the thoracic walls, or of a portion of intestine through the abdominal parietes, is termed a hernia of the organ; but the descent of the bowel through the anus does not come under this designation. Here, however, we have to consider only the hernial protrusions that occur from the abdomen.

A hernia may occur at almost any part of the abdominal wall; though it is far more liable to do so in some situations than in others, being commonly met with at those points where the muscular and tendinous structures are weakened to allow the passage of the spermatic cord in the male, and of the round ligament in the female; or for the transmission of the large vessels to the lower extremity; hence the inguinal and crural canals are the common situations of this disease. It may, however, occur elsewhere, as at the umbilicus, the thyroid foramen, the sciatic notch, in the vagina, the perinæum, through the muscular portions of the abdominal wall, the diaphragm, &c.

Structure of a Hernia.—In whatever situation it occurs, a hernia is composed of a **Sac** and its **Contents.**

The **Sac** is the prolongation of that portion of the peritoneum which corresponds to the aperture through which the hernia protrudes. It is in all cases composed of a *neck* and a *body.*

The **Neck** is usually narrowed, though in some old herniæ it becomes wide and expanded; it is commonly short, consisting indeed of a sudden constriction of the sac in this situation, as happens in many forms of femoral hernia; but in other cases it is elongated and narrowed. The neck of the hernial sac usually becomes greatly thickened and of an opaque colour, by the growth of fibroid tissue in or upon it from the irritation to which it has been subjected by the pressure of the hernial tumour or the truss, by the incorporation of the subserous areolar tissue lying externally to it, or by the puckering together of its folds, which have been compressed in the aperture.

The **Body** of the sac is usually globular or pyriform, sometimes elongated and cylindrical; it may vary from the size of a cherry to a tumour as large as the head. When recent, it is usually thin and transparent, though in some cases it becomes greatly thickened, having arborescent vessels ramifying in it, and being almost laminated in structure; this is especially the case in old femoral herniæ. In other instances, however, it becomes thinned and atrophied as the tumour expands, so that the contents become visible through it. This is especially the case in old umbilical herniæ, in which I have seen it as thin as the finest gold-beater's skin.

The sac, though usually forming a perfect inclosure to the hernial contents, occasionally constitutes but a partial investment to them, more particularly in such organs as the cæcum or bladder, which are partially uncovered by peritoneum. In other instances it may be ruptured, or altogether wanting. The sac is absent when the hernia occurs as the result of a wound, injury, or abscess of the abdominal wall. It cannot be said to exist in a congenital hernia, and may be absent in cæcal and in umbilical herniæ. More rarely a double hernial sac is met with, one being protruded into or placed behind the other. There are instances of three sacs occurring together ; and Sir A. Cooper relates a case in which six were met with in the same person.

The abdominal parietes outside the sac undergo important changes. The aperture through which the hernia protrudes usually becomes circular ; after a time, indurated and rounded at the edge, and considerably enlarged ; when situated in the movable portions of the abdominal wall, as in the inguinal region, it becomes displaced in old herniæ, being dragged down by the weight of the protrusion, usually towards the mesial line. The subserous areolar tissue always becomes greatly thickened, often indurated, so as to constitute one of the densest investments of the sac, and, in some old cases of hernia, closely to resemble omentum. The more superficial structures, such as the integument and fascia, are much elongated and stretched ; often tense, but not unfrequently hanging in folds ; they are usually thinned, but, if a truss have been long worn, they become thickened and condensed by the pressure of the pad.

Contents.—The contents of the sac vary greatly ; every viscus except the pancreas having been found in a hernial tumour. Most frequently a portion of the *Small Intestine*, more particularly of the ileum, is protruded, constituting the form of hernia called **Enterocele**. The quantity of intestine within the sac may vary from a small section of the calibre of the gut, the whole diameter not being included, to a coil several feet in length with its attached mesentery. After a portion of gut has once descended, the protrusion tends to increase, until, as in some large and old herniæ, the greater portion of the intestine has been known to lie in the sac. The *Large Intestine* is less often found in a hernia, though the cæcum is not uncommonly met with. When intestine has been long protruded, it usually becomes thickened, narrowed, greyish on the surface, and more or less deranged in its functions. The corresponding mesentery becomes thickened, hypertrophied, and vascular.

Omentum is often found in hernial sacs, together with intestine ; but is not unfrequently met with alone, constituting **Epiplocele**. After having been protruded for some time it becomes thickened, brawny, and laminated, losing its ordinary texture, and becoming indurated. Its veins usually assume a somewhat varicose condition ; and the mass of omentum becomes pyramidal in form, the apex being upwards at the abdominal aperture, and the base below, broad and expanded. In some cases it can be unfolded ; in others, it is matted together into a solid mass. Occasionally apertures form in it, through which a coil of intestine may protrude, thus becoming strangulated within the sac. In other instances, cysts are met with in it containing fluid. When intestine and omentum together are found in a hernia, the disease is termed an **Entero-epiplocele** ; and in these circumstances the omentum descends in front of and occasionally envelops the intestine. Besides these, the ordinary contents of herniæ, the stomach, liver, spleen, cæcum, sigmoid flexure of the colon, bladder, uterus, and ovaries, have all been found in them. In a case described by Scanzoni, the gravid uterus and ovaries were enclosed in the sac of an inguinal hernia.

Adhesions commonly form within the sac in old-standing cases. These may take place between the contained viscera merely, as between two coils of intestine, or between these and the omentum; or they may form between the wall of the sac and its contents, either by broad bands, or else by bridging across from one side to the other, and enclosing a portion of the viscera. In recent cases these adhesions are soft, and may readily be broken down; but when of longer duration, they are often very dense, and are especially firm about the neck of the sac.

Besides the viscera, the hernial sac always contains a certain quantity of *fluid* secreted by and lubricating its interior. In most cases, this is in but small quantity; but in some instances, when the sac is inflamed, or the hernia strangulated, a very considerable amount is met with; I have seen as much as a pint escape from a large hernia in an old man. In strangulated or inflamed hernia, it is generally of a reddish colour, though clear and transparent.

Hydrocele of the Hernial Sac.—In some instances the fluid becomes collected in a kind of cyst within the sac, formed by the omentum contracting adhesions to its upper part and leaving space below for the fluid to collect; this condition, represented in the annexed drawing (Fig. 801), has been called *Hydrocele of the Hernial Sac,* and is somewhat rare. The fluid is often in considerable quantity; in a case which I tapped some years ago, nearly three pints of dark-brown liquid had thus accumulated, and were drawn off.

If we limit the term *hydrocele of the hernial sac* to those cases in which there is a slow and gradual accumulation of fluid at the bottom of an old hernial sac, which has been cut off from all communication with the peritoneum by the adhesion of intestine or omentum to the upper part and neck, it must be considered a rare disease; and but few cases are recorded by surgical writers. Curling, in his work on the *Testis,* states that he had seen only one case; and the only others with which I am acquainted, besides one that occurred in my own practice, are two related by Pott, two by Pelletan, one by Boyer, and one by Lawrence. This disease must not be confounded with the accumulation of fluid, in whatever quantity, in strangulated herniæ, or in hernial sacs that communicate with the peritoneal cavity. Its distinguishing feature is the accumulation of fluid in a part of the sac that has been cut off from all communication with the cavity of the peritoneum.

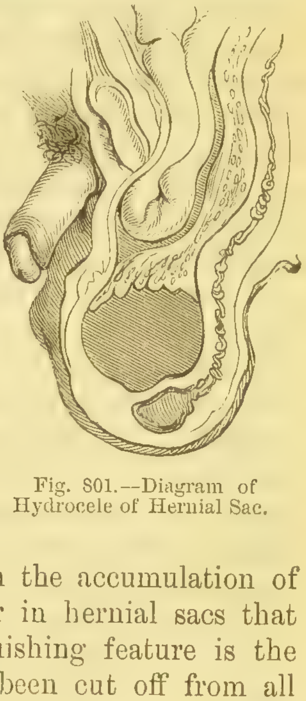


Fig. 801.—Diagram of Hydrocele of Hernial Sac.

An Accumulation of Ascitic Fluid in a Hernial Sac may occur when hernia is complicated with ascites. In one case of this kind which occurred in my practice, the hernia, which was femoral, in a woman, was very tightly strangulated, as large as a shaddock, very tense, with distinct fluctuation; the skin covering it being much stretched, this was peculiarly evident. On opening the sac, fluid flowed in a jet, as if a hydrocele had been punctured, and about four inches of strangled gut were found lying at the bottom of the sac. After dividing the stricture, serous fluid in large quantity continued to drain from the peritoneal cavity for several hours after the operation.

An Accumulation of Fluid in a Hernial Sac which has been obliterated at its neck is occasionally met with, chiefly in the femoral region, though occasionally also in the inguinal. A case of this kind occurred not long ago in University College Hospital. The patient, a middle-aged woman, was suddenly seized with pain in the abdomen, and bilious vomiting. On examining the groin a tense rounded tumour was found in the region of a femoral hernia. It was free from tenderness and fluctuated indistinctly. On cutting down upon it, it was found to be an old hernial sac distended with clear serous fluid, but without solid contents. While examining the ring the adhesions at the neck of the sac gave way, and the finger slipped into the abdominal cavity. The vomiting and pain proved to have been nothing more than an ordinary "bilious attack," and the patient speedily recovered.

Loose Foreign Bodies have occasionally been met with inside hernial sacs. They are usually rounded, smooth, and firm ; vary in size from a pea to a chestnut ; and are mostly single. On section, they are found to consist of a fatty central nucleus with a laminated fibrous envelope, usually of considerable thickness. They are apparently composed of one of the appendices epiploïcæ, which has become detached, fallen loose into the peritoneal cavity, and become enveloped in fibrinous layers.

Signs of Hernia.—The signs of hernia, though varying considerably according to the contents of the sac and the condition in which it is placed, present in all cases many points in common. There is an elongated or rounded tumour at one of the usual abdominal apertures, broader below than above, where it is often narrowed into a kind of neck. The swelling usually increases in size when the patient stands, holds his breath, coughs, or makes any forcible muscular exertion. It can be pushed back into the abdomen on pressure, slipping away suddenly from under the hand. As this takes place, if intestine is present, a characteristic gurgle is heard and felt. It usually goes back readily if the patient lie down, but reappears when he stands up. On coughing, a strong and distinct impulse may be felt in it.

When the hernia is altogether **Intestinal,** it is usually smooth, gurgling when pressed upon, sometimes tympanitic and rumbling, and resonant on percussion. It may be returned into the cavity of the abdomen with a distinct slip and gurgle ; it has a well-marked impulse on coughing, and is usually accompanied by various dyspeptic symptoms, and often with much dragging uneasiness. **Omental Hernia** is usually soft and doughy, returning slowly on pressure into the abdomen, feeling irregular on the surface, and having an ill-defined outline. It occurs most frequently on the left side, and is rare in infants, in whom the omentum is short. In **Entero-epiplocele** there is a combination of the two conditions and their signs ; but these are usually so uncertain, that few Surgeons care to predict before opening the sac what the probable nature of the contents may be.

Cæcal Hernia necessarily occurs on the right side only. It is a large, knobby, and irregular tumour, irreducible, owing to the adhesions contracted by that portion of cæcum which is uncovered by peritoneum. The peculiarity of this hernia consists in the sac being absent, or only partial in the majority of cases, the peritoneum being stripped off as the gut descends. When this hernia is large, and partially invested by serous membrane, a sac usually exists at its upper aspect, into which a portion of small intestine may fall, and which may in some cases constitute a second hernia lying above or before the cæcal one, which will be found situated at the posterior wall when this hernial pouch is opened. Occasionally the vermiform appendix and the caput coli are found in the sac, but can rarely be returned. The rule of cæcal hernia having a partial peritoneal investment only, does not hold good in all cases; and instances have occasionally been met with in which this portion of intestine lay in a distinct sac.

Hernia of the Bladder or Cystocele is very rare; and, like that of the cæcum, is usually enclosed in a partial peritoneal investment, though it is not necessarily so. South states that there is a preparation at St. Thomas's Hospital, in which the fundus of the bladder, with its peritoneal covering, has passed into a distinct sac. In some instances the cystocele is accompanied by an enterocele. This hernia is always irreducible, is attended by a good deal of difficulty in urinating, with varying tension, according to the quantity of fluid contained; by squeezing it, urine may be forced out through the urethra, and fluctuation has been felt in it. Urinary calculi have been formed in the tumour, and have been removed by incision through the scrotum, or have ulcerated out.

CAUSES.—The causes of hernia are usually sufficiently well marked. In some instances the disease is *congenital*, arising from preternatural patency of the abdominal apertures; in other cases, it occurs at a later period of life, in consequence of some *forcible effort*, as lifting a heavy weight, jumping, coughing, straining at stool, or passing urine through a tight stricture. Such causes as these act especially in tall and delicate people, particularly in those who have a natural disposition to weakness or bulging of the groins. The displacement of the abdominal viscera by a *gravid uterus*, will also occasionally give rise to the disease. Hernia frequently results from a combination of causes: thus, if an aged person of feeble build, or whose abdominal apertures are patent in consequence of rather sudden emaciation, make a violent effort, a hernial protrusion is very apt to occur.

Amongst the most frequent **Predisposing Causes** of hernia, are sex, age, and occupation.

Sex.—Men are more liable to this disease than women, in the proportion of about 4 or 5 to 1. Thus, according to Malgaigne, in France, one man in thirteen and one woman in fifty-two are the subjects of hernia. But, though men are more generally liable to hernia than women, they are less so to certain forms of the disease, especially to the femoral and umbilical. It is to the inguinal that they are particularly subject. According to Lawrence, out of 83,584 patients who applied to the City of London Truss Society, 67,798 were males and 15,786 females. Of 43,214 applicants at the same institution during the eight years 1860-1867, 36,161 were males and 7,053 females. Of these, 34,788 males, and 3,085 females had inguinal hernia; 1,373 males, and 3,968 females had femoral hernia.

Age exercises a very material influence upon the frequency of hernia. Malgaigne, who has carefully investigated this subject, finds that in infancy the disease is sufficiently common, owing to the prevalence of congenital inguinal and umbilical herniæ at this period of life; and that, in the first year after birth, hernia occurs in the proportion of 1 in every 21 children. It then goes on decreasing in frequency, there being 1 in 29 at the second year; 1 in 37 at the third year; until, at the thirteenth year, it has fallen to 1 in 77. Shortly after this, its frequency begins to rise again, and then goes on progressively increasing until the close of life; thus, at the 21st year, there is 1 case in 32; at the 28th year, 1 in 21; at the 35th, 1 in 17; at the 40th, 1 in 9; at 50, 1 in 6; from 60 to 70, 1 in 4; and from 70 to 75, 1 in 3. In women, according to Malgaigne, hernia most frequently occurs from the 20th to the 50th years.* Malgaigne's figures give the ages of the patients when they came under his observation. Kingdon has investigated the question of the ages at which the hernia commenced. He states that out of 9,296 cases, 5,659, or 60·8 per cent., had commenced before 35, and 3,637, or 39·2 per cent., after that age. The tendency to hernia is often *hereditary*, and congenital hernia is common in the children of hernial parents. Some races of men are less subject to hernia than others. Thus it is less frequent in the negro than in the white man, except in the ventral form.

Occupation.—Those occupations in which the individual is exposed to violent muscular efforts, more particularly of an intermitting character, predispose to the occurrence of hernia ; and in these employments the tendency to the disease is often increased by the injurious habit of wearing tight girths or belts round the waist, which, by constricting the abdomen, throw the whole pressure of the abdominal contents upon the inguinal regions. Hernia is also common in men such as railway drivers, cavalry soldiers, and artillery-men, exposed to much jolting in the upright or nearly upright position.

Other Causes.—It is probable also that hernia is predisposed to by the height of the seats of water-closets in common use. In the natural position assumed by man in defæcation the femoral and inguinal rings and the lower part of the abdomen are supported by the flexed thighs, whereas on the ordinary water-closet seat the thighs are not flexed much beyond a right angle, and the support is consequently much less perfect. The frequency with which hernia appears for the first time or becomes strangulated during defæcation would lend some support to this view. Habitual constipation is a predisposing cause in many cases. Rapid emaciation from any cause is not unfrequently followed by a hernial protrusion.

Conditions presented by Hernia.—The conditions in which a hernia may be found are very various, and entail corresponding differences in the result and treatment of the affection. When first formed, most herniæ may be said to be *Incomplete*, being for a time retained within the orifice of the canal through which they eventually protrude. When they have passed altogether beyond the abdominal walls, they are said to be *Complete* ; and this is the condition in which they are usually presented to the Surgeon. A hernia may also be *Reducible*, *Irreducible*, or *Strangulated*.

REDUCIBLE HERNIA.

A hernia is commonly at first **Reducible** ; that is to say, it may readily be pushed back into the cavity of the abdomen, protruding again when the patient stands up, holds his breath, or makes any exertion, and having a distinct and forcible impulse on coughing. Though the contents, in these cases, are reducible, the sac is not ; it almost immediately contracts adhesions to the areolar tissue, by which it is firmly fixed in its new situation ; though in some cases, as we shall hereafter see, it may be pushed back.

The question as to whether a hernia is of recent origin or of old standing sometimes presents itself in medico-legal practice. In determining this the following points deserve attention :—1. A recent hernia resulting from injury is attended with pain—usually severe—from laceration of the structures of the abdominal wall. 2. When oblique, inguinal or femoral, it may be small, but when direct, inguinal or ventral, it is often large and rounded, the aperture through which it protrudes being irregular and wide. 3. The margins of the aperture in an old hernia are more rounded than in one of recent formation. 4. Recent herniæ are intestinal, not omental. 5. They are readily reducible; whilst old herniæ are frequently irreducible in whole or in part, and omental. 6. After reduction the sac of a recent hernia when rolled between the fingers will feel thinner and softer than that of an old one. 7. Strangulation may occur at the moment of protrusion of a hernia. Hence, although more frequent in old than in recent herniæ, its existence does not prove the hernia to be old. 8. In old herniæ, if the patient has worn a truss, there will usually be signs of pressure, or of chafing of the skin.

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* Those interested in the statistics of Hernia will find much information in an elaborate article by A. Wernher, of Giessen, in Vol. XI. of Langenbeck's "Archiv für Klinische Chirurgie" (1869), and in "Reports of Provost-Marshal General's Bureau, United States Army, 1876."

Application of Truss.—In the Treatment of a reducible hernia, our object is to retain the protrusion within the cavity of the abdomen. In order to do this, the patient must be provided with a proper kind of truss, adapted to the particular nature of the hernia. In umbilical and ventral ruptures, an elastic pad and belt may most conveniently be used. In selecting the truss, care should be taken that the spring be of proper strength, adapted to the size and power of the individual; and that it be properly shaped, so that it does not touch any part of the abdominal wall, but merely bears upon the points of pressure and counter-pressure. The pad should be convex, firmly stuffed, and of sufficient size to press, not only upon the external aperture, but upon the whole length of the canal. Before applying the truss, the hernia must be reduced, by placing the patient in the recumbent position, relaxing the muscles by bending the thigh upon the abdomen, and pressing the tumour back in the proper direction ; the truss should then be put on, and be worn during the whole of the day ; indeed, the patient should never be allowed to stand without wearing it. At night, it may either be left off altogether, or a lighter one applied. The patient should be provided with a " bathing " truss, that is, a truss covered with india-rubber, so as to resist the action of the water. It is well that the ordinary truss be covered with linen, so that the leather may be kept clean, and unstained by perspiration and the spring free from rust. In some cases, the skin becomes irritated by the pressure of the pad ; in these circumstances, an elastic air-cushion may be used, or the parts subjected to pressure may be well washed with spirit-lotion. The truss may be known to fit by testing it in the following way. The patient should be made to sit down on the edge of a chair, and then, extending his legs, opening them widely, and bending the body forwards, cough several times. If the hernia do not now slip down behind the pad, we may be sure that the truss is efficient, and will keep the rupture up in all ordinary circumstances.

It is the Surgeon's duty to tell the instrument-maker what form of truss is required, and to see that the instrument supplied fulfils its object. It is always better for the instrument-maker to see the patient and measure him for the truss, but in country practice this is often impossible, and the Surgeon must then measure the patient himself and order the required instrument. The most important measurement is the circumference of the pelvis taken midway between the crest of the ilium and the trochanter major. Most instrument-makers say that this is all they require ; but to insure accuracy, it is better to send also the exact measurement in the line in which the truss will lie, commencing at the centre of the ring, and passing round the pelvis midway between the crest of the ilium and the trochanter, and terminating at the ring again. The Surgeon must also inform the instrument-maker of the nature of the hernia, the side on which it is situated, the size of the ring, the age, sex, and physical power of the patient. He must state also if his occupation is such as to necessitate a spring of more than ordinary strength.

Radical Cure of Hernia.—Various means have been devised in order to effect the radical cure of a reducible hernia. The only plan that is perfectly free from danger is the compression of a well-made truss. In this way, not unfrequently, the herniæ of infants become radically cured ; the same result, however, seldom occurs at a more advanced period of life. In order that compression in this way may succeed, it is necessary that it should be applied not only to the external aperture through which the rupture escapes, but to the whole of the canal. It must also be continued for a very considerable time, at least a year or two ; and care should be taken that during the treatment the rupture is not allowed to descend. Every time it comes down, any good that may have been derived is necessarily done away with, and the treatment has to begin, as it were, anew. Radical cure of a hernia by truss-pressure can be effected only in those cases in which the abdominal aperture has been left congenitally weak or open. Hence it can be hoped for only in children and very young adults, and only in those two congenital forms of hernia—the umbilical and the inguinal. The continued pressure of the truss in these cases seems to determine the adhesive processes necessary for the closure of one of the abdominal apertures. After the cure is supposed to have been effected in this way, the truss must be worn for a very considerable length of time, lest by any violent movement the rupture be forced down again.

The **Operations** that have been devised for the radical cure of hernia are founded on one of four principles ; first, to excite such an amount of inflammation in the sac, or its neck, as to cause its obliteration ; secondly, to invaginate the sac and the subcutaneous tissue in the hernial aperture in such a way as to plug it completely ; thirdly, by the *subcutaneous* introduction of wire, silk, or other ligatures to invaginate the sac and subcutaneous areolar tissue and at the same time to close the ring ; and, lastly, by an *open operation*, to expose the sac, and either to invaginate it or remove it after ligaturing its neck and then to close the ring by sutures. The last of these methods is by far the most ancient, and was frequently applied to inguinal herniæ in the middle ages either by surgeons or by travelling quacks. It, however, fell into disrepute owing to the mortality that attended it until the introduction of the antiseptic method of treating wounds robbed it of the greater part of its dangers. In 1871 Sir Joseph Lister reported two cases in which he had cut down upon a hernial sac and closed the opening with cat-gut sutures, but this method of operating was found to be uncertain in its results. Since then Annandale, Banks, Czerny, Macewen, Ball, and many others have introduced modifications and improvements which have rendered the operation both safe and effectual.

Those methods of radical cure in which it was attempted to cause obliteration of the sac or its neck by exciting inflammation in it by the introduction of caustics, by scarification, by puncture, or by injection of iodine were found so dangerous and ineffectual that they have been altogether abandoned.

Whatever method be adopted failure must occasionally occur, as really to accomplish a radical cure it would be necessary in some cases to effect changes in the shape and connections of the abdominal contents, to alter the size of the cavity and to modify in various ways many conditions independent of those immediately connected with the hernial protrusion.

Radical cure is no longer confined to inguinal herniæ, and consequently the details of the operation will be most conveniently considered with the special herniæ.

IRREDUCIBLE HERNIA.

Irreducible Herniæ are usually of old date, and of large size. They generally contain a considerable quantity of thickened omentum, as well as intestine and mesentery. In many instances, a rupture of this kind is partly reducible, the greater portion remaining unreduced. It is usually the gut which slips up, and the omentum that cannot be returned.

Causes of Irreducibility.—The irreducibility of a rupture may be dependent either on its *shape*, on the existence of *adhesions*, or on its very *nature*. If the sac become the seat of an hour-glass contraction, or its neck become elongated and narrowed, the hernial contents may continue permanently protruding. So also, the expanded condition of the lower part of the omentum, and the narrowing of its neck, may prevent a return of the rupture. The existence of adhesions, either between the sac and its contents, or between protruded intestine and omentum, will commonly render a hernia irreducible; and most frequently these are associated with changes in the shape of the sac or of the omentum. Herniæ of the cæcum and bladder can never be returned, on account of the anatomical conditions to which reference has already been made.

Symptoms.—An irreducible hernia is usually a source of great inconvenience; it has a tendency to increase if left to itself, until at last it may contain, as in some extreme cases it has been found to do, the greater portion of the abdominal viscera, forming an enormous tumour, inconvenient by its size and weight, in which the penis and scrotum are buried. Even when the irreducible hernia is of small size, it gives rise to a sensation of weakness in the part, with dragging pains, and is very frequently accompanied by colicky sensations and dyspeptic derangements. The patient also, in these circumstances, is in a state of considerable danger lest the rupture become strangulated by violent efforts, or injured by blows.

Treatment.—For the above reasons it is necessary not only to protect a rupture of this kind from external violence, but to endeavour to prevent its increase in size. This may best be done by letting the patient wear a truss with a large concave pad, which supports and protects the hernia; provided it be not of too great a size for the application of such an instrument. If its magnitude be very considerable, it must be supported by means of a suspensory bandage. Bransby Cooper recommended that an attempt should be made to convert the irreducible into a reducible hernia, by keeping the patient in bed for several weeks, on low diet, with the continued application of ice to the tumour. If it contains much omentum, and the patient be fat, the diet may be regulated accordingly. All food containing starch or sugar, except a small quantity of bread, and all alcoholic drinks must be forbidden. The patient must be fed on a small quantity of lean meat and green vegetables. At the same time a dose of blue pill and a saline purgative must be given occasionally. The scrotum, if the hernia be inguinal, must be raised on a pillow, and the foot of the bed may also be elevated. Taxis may be attempted daily. By this plan I have seen very large irreducible herniæ returned in a few weeks. If the patient be young and otherwise healthy, the question of performing the operation for radical cure by opening the hernia, dissecting through the adhesions, removing the sac and sewing up the ring, may be considered. Such an operation, however, should not be rashly undertaken if the hernia be large and the patient fat.

Inflamed Irreducible Hernia.—The occurrence of inflammation in an irreducible hernia is a serious complication, and one that simulates strangulation very closely. When this complication occurs, the part becomes swollen, hot, tender, and painful ; there is not much tension in the tumour, which is seldom increased beyond its usual magnitude ; there is a good deal of pyrexia, and symptoms of peritonitis spreading from the vicinity of the inflamed rupture set in. In some cases there is vomiting ; but it is not constant, and never fæculent, occurring generally early in the disease, and consisting principally of the contents of the stomach ; being apparently an effort of nature to get rid of an indigestible meal. If there be constipation, as usually happens in all cases of peritonitis, it is not complete, flatus occasionally passing *per anum*, together with a small quantity of fluid fæces. It is of importance in these cases to observe that the inflammation commences in the body of the sac, and extends into those parts of the abdomen that are contiguous to its neck ; the gastric and intestinal derangements being secondary.

The *Treatment* of an inflamed irreducible hernia must be directed to the peritonitis which attends it. The application of leeches over the sac and its neck, and the administration of opium or hypodermic injections of morphia if the vomiting continues, followed by hot fomentation, with strict antiphlogistic regimen and rest, will usually speedily subdue all signs of inflammation.

Incarcerated Hernia.—An irreducible hernia occasionally becomes obstructed, then constituting the condition termed *incarcerated hernia.* This occurs principally in old people, from the accumulation of flatus, or of undigested matters, such as cherry-stones or the remains of a large meal of cabbage or spinach, in a coil of the gut. In these cases there is constipation, with eructation, and perhaps occasional vomiting. There may be some degree of pain, or uneasiness about the tumour ; but there is no tension in it or in its neck, and the symptoms altogether are of a chronic or subacute character.

The *Treatment* of such a case as this should consist in the administration of a good purgative injection ; the compound colocynth enema is the best, thrown up as high as possible by means of a long tube. Ice may then be applied to the tumour for about half an hour ; and the taxis, as will afterwards be described, may be used under chloroform. The ice may be omitted in those cases in which, on handling the tumour, gurgling can readily be felt ; but the taxis should always be used, as by it the incarcerated gut may be partially emptied of its contents ; or if any additional protrusion should have slipped down, this may be returned. After these means have been employed, an active purgative, such as a full dose of castor oil or a calomel and colocynth pill may be administered. Should there be any signs of inflammation, purgatives must be avoided, and the case treated as already described.

STRANGULATED HERNIA.

A hernia is said to be **Strangulated** when a portion of gut or omentum that is protruded is so tightly constricted that it cannot be returned into the abdomen; having its functions arrested, and, if not relieved, speedily running into gangrene. This condition may occur at all periods of life, being met with in infants a few days old, and in centenarians. It commonly arises from a sudden violent effort, by which a fresh portion of intestine is forcibly protruded into a previously existing hernia, which it distends to such a degree as to produce strangulation. But, though old herniæ are more subject to this condition than recent ones, it may occur at the very first formation of a hernial swelling, the gut becoming strangled as it is protruded. There are therefore two distinct kinds of strangulation. One may be said to be passive, occurring chiefly in elderly people, the subjects of old and perhaps irreducible herniæ; which, in consequence of some accidental circumstance, become distended by the descent of a larger portion of intestine than usual, and this, undergoing constriction at the neck of the sac, gradually becomes strangulated. The other kind is more frequent in younger individuals; in it the symptoms are active, the bowel becoming protruded in consequence of violent exertion, and undergoing rapid strangulation, the tension of the parts not having been lessened by the previous long existence of an irreducible hernia.

Mechanism of Strangulation.—Strangulation has been attributed either to a spasmodic action of the walls of the aperture through which the hernia protrudes, or to changes taking place in the protruded parts, occasioned by their constriction by the tissues external to them. Strangulation cannot, I think, ever be regarded as of spasmodic character; for the aperture in the abdominal wall, through which the hernia escapes, is tendinous or fibrous, and certainly not in any way contractile, though the action of the abdominal muscles may undoubtedly increase the tension of its sides. The continued and permanent character of the strangulation also, when once it has taken place, would discountenance this opinion; those forms of hernia, indeed, as the ventral, which occur in purely muscular structures, are very rarely strangulated, and, when they are, the constriction is generally occasioned by the formation of dense adventitious bands upon or within the sac, and not by any muscular action.

Strangulation is characterized by congestion of the protruded parts, induced by the constriction to which they are subjected; the mechanism being as follows. A knuckle of intestine, or piece of omentum, is suddenly protruded during an effort of some kind. This immediately becomes compressed by the sides of the narrow aperture through which it has escaped; the return of its venous blood is consequently interfered with, and swelling and œdema rapidly ensue, culminating in stagnation of the blood in it. If the constriction be excessively tight, the walls of the ring being very hard and sharp, the part that is so strangulated may be deprived of its vitality in the course of a few hours. If the strangulation be less severe, so that the circulation is not entirely arrested, the changes characteristic of inflammation will supervene. In proportion as the congestion augments, the return of the protruded parts is necessarily rendered more difficult by the increase of their swelling.

Seat of Stricture.—The stricture is very commonly situated outside the neck of the sac, in the tendinous or ligamentous structures surrounding it;

not unfrequently in the altered and thickened subserous areolar tissue. In other cases, and indeed with great frequency, it is met with in the neck of the sac itself (Fig. 802), which is narrowed, elongated, and tubular; or constricted by bands that are incorporated with it. More rarely it exists in the body of the sac, which may have assumed an hour-glass shape. In some cases, it would appear as if this particular shape were owing to an old hernia having been pushed down by a recent one above it. The stricture is sometimes, though by no means frequently, met with inside the sac, consisting of bands of adhesions stretching across this, or of the indurated edge of an aperture in the omentum through which a portion of the gut has slipped.

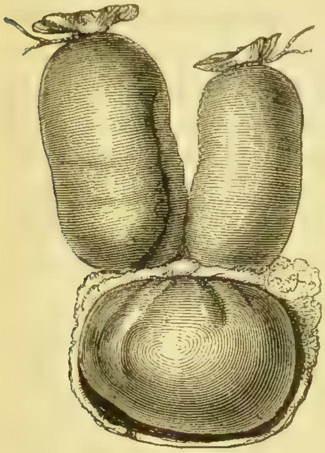


Fig. 802.—Stricture in the Neck of the Sac, laid open.

Local Effects of Strangulation. — The changes induced in the strangulated parts result from the pressure of the stricture, and the consequent interference with the circulation through them. If the strangulation be acute, that portion of intestine which lies immediately under the stricture will be seen to be nipped or marked by a deep sulcus, occasioned partly by the pressure to which it has been subjected, and partly by the swelling of the congested tissues beyond it. The changes that take place in the protruded intestine rapidly increase in proportion to the duration of the strangulation. The tightness of the stricture and the acuteness of the strangulation have, however, even more to do with these changes than its duration. I have seen the bowel so tightly nipped that, though the strangulation had existed only eight hours when the operation was performed, the vitality was lost in the part constricted (Fig. 808); and in other cases I have known the part to recover, although strangulation had lasted for five or six days.

The first change that takes place in the protruded parts in the case of strangulated hernia is their *congestion.* This is purely mechanical, and arises from the fact that at first the pressure is seldom sufficient to arrest the arterial flow, while it seriously impedes that through the veins. As a consequence of this the gut gradually swells, and at last the arterial flow is arrested also. The gut becomes at first of a claret, maroon, or purplish-brown colour, sometimes ecchymosed on the surface, with thickening and stiffening of its coats owing to effusion into their substance. At the same time the sac becomes distended with fluid poured out from the over-distended vessels before the circulation is completely arrested. The vessels of any omentum that may be present in the sac will be similarly distended. The interference with the circulation necessarily leads to a progressive diminution of vitality, which speedily terminates in gangrene of the strangled gut. The phenomena of inflammation cannot manifest themselves after the circulation is arrested. In fact in all cases of severe and rapid strangulation they are entirely wanting, the surface of the gut being free from lymph, and the fluid in the sac perfectly clear though darkly stained with blood. In the cases of slow strangulation, on the other hand, in which the gut is so loosely held that circulation continues, although the passage of fæces is arrested, the signs of inflammation are commonly met with. In these cases the bowel is dark in colour, though not so dark as in more acute strangulation, and is coated here and there with flakes of lymph, which give it a rough and villous look; the omentum has a somewhat rosy tinge, and there is usually a good deal of pale reddish fluid containing flakes of lymph in the sac. It is theoretically possible that in some cases the strangulation may be so complete and sudden that the arterial and venous flow would be simultaneously arrested. In such a case the gut would be pale and the sac free from fluid. Such a condition, if it does occur, is of infinite rarity. When *gangrene* occurs, the bowel loses its lustre and polish, becoming of an ashy-grey, or dull-black colour, soft and somewhat lacerable, so that its coats readily separate from one another; the serous membrane especially peeling off. The omentum is dark purplish, or of a kind of dull yellowish-grey; and there is usually a considerable quantity of dark turbid serum in the sac, the whole contents of which are more or less offensive. Most usually, when gangrene occurs in a strangulated rupture, inflammation of the sac and its coverings takes place, accompanied, after a time, by a reddish-blue or congested appearance and some tenderness on pressure; and, if the part be left unreduced, eventually by emphysematous crackling. If the case be left without relief, gangrene of the skin will at last take place; the sac giving way, and the fæcal matters being discharged though the softened and disintegrated tissues. In such circumstances as these—which, however, are very rarely met with at the present day—the patient usually dies from exhaustion. In exceptional cases peritonitis may be set up by ulceration and perforation of the gut immediately above the seat of stricture, but in the great majority this does not take place as the portion of bowel immediately within the stricture becomes adherent to the wall of the abdomen and the neighbouring coils of intestine, and thus fæcal extravasation is prevented. It does not follow that there is always external evidence of the occurrence of gangrene within the sac; and the bowel is frequently nipped to such an extent as to prevent its regaining its vitality, without any unusual condition being presented until the sac is actually laid open and the intestine examined.

The *fluid* contained in the hernial sac undergoes changes in appearance and character, corresponding to those which take place in the strangled gut. In earlier and slighter cases it continues clear and but moderately abundant. Sometimes the quantity increases greatly and rapidly, but more commonly the chief alteration that takes place is in its character. It becomes reddish or brown in colour from transuded blood. Sometimes even pure blood is found in the sac, and I have seen the protruded intestine invested with a layer of coagulum. If gangrene of the gut takes place, the fluid becomes turbid, dark, and offensive. Suppuration in the sac is very rare. I have only once met with it in a woman, 32 years of age, three months pregnant, who was suffering from an acutely strangulated femoral hernia of sixty hours' duration. In that case, taxis had been freely used. Fluctuation could be felt deeply, there was diffused doughy infiltration of the groin, and on opening the sac it was found filled with dark thick pus—about half an ounce; at the bottom of which lay a small deeply congested but not gangrenous knuckle of intestine, which was replaced after the division of a very slight stricture. The patient recovered.

Inflammation of the Gut after relief of Strangulation occurs in a large proportion of cases. It has been already pointed out in the chapter on Inflammation (Vol. I., p. 165) that the arrest of circulation through a part of the living body produces different effects according to the length of time that it is kept up. If the arrest is complete and of sufficient duration, gangrene sets in, such blood as the vessels contain coagulates, and on relief of the strangulation the blood is unable to enter the dead tissues. If the arrest of the circulation has been maintained for a length of time sufficient to lower the vitality of the part considerably but not to kill it, on the relief of strangulation all the phenomena of inflammation manifest themselves. The vessels become engorged with blood, abundant exudation takes place causing great swelling by which the feeble circulation may be again arrested and gangrene may set in. In other cases the inflammation may fall short of this, but may, in the case of the intestine, be sufficient to suspend the functions of the affected part so that although the strangulation is relieved, the obstruction to the passage of fæces remains for some days, or even till death results. If the arrest of circulation has been less complete or of shorter duration, the relief of strangulation is followed by temporary hyperæmia, which soon subsides. It is not uncommon in fatal cases to find the coil of intestine free from gangrene, but swollen, covered with a thick layer of inflammatory exudation fixing it to the neighbouring coils, and evidently incapable of performing its functions. This inflammation after reduction is a fact of great importance, as it shows the necessity of giving the gut rest as far as possible after the strangulation has been relieved by the avoidance of purgatives or irritating food.

It was formerly assumed that in all cases of prolonged strangulation general peritonitis sets in. This assumption is not borne out by the results of the *post-mortem* examination of cases dying of unrelieved strangulation. In such cases, as a rule, local peritonitis is found at the neck of the sac, but the membrane generally is free from any signs of inflammation. Should inflammation occur it is always slight, and seems to be secondary to acute inflammation of the mucous membrane of the intestine above the stricture, which in too many cases is the result of the injudicious administration of purgatives.

SYMPTOMS.—The signs and symptoms of strangulation are of two kinds: 1. Local; and 2. General.

1. **Local Signs.**—The tumour, if the hernia be an old one, will be found to be increased in size; or it may have appeared for the first time. At the moment of strangulation it will generally be found to be hard, tense, and rounded, more particularly if it be an enterocele. When, however, the hernia is in a great measure omental, it is not unfrequently soft and doughy, though strangulated. After strangulation has occurred no fresh protrusion can take place below the stricture; but the tumour may be greatly augmented in bulk after the strangulation had existed for some hours, by the effusion of serum into the sac. If the hernia have previously been reducible, it can no longer be put back; and there is no impulse in it nor increase in its size on coughing, the stricture preventing the transmission of the shock to the contents of the tumour; and in this way, as pointed out by Luke, the situation of the constriction may sometimes be ascertained by observing at what point the impulse ceases. In most cases there is considerable local tenderness.

2. **Constitutional Symptoms.**—As soon as the strangulation has occurred, intestinal obstruction takes place, and the patient becomes uneasy and restless. If the constriction be of an active character, he will be seized with acute pain in the part, which speedily extends to the contiguous portion of the abdomen.

The first thing that happens when intestine is strangulated, whether a large coil be constricted, or a small portion only of the diameter of the gut be nipped, is an arrest of the peristaltic movement of the part implicated; and the occurrence of obstruction to the onward course of the intestinal contents is followed by constipation, vomiting, and colicky pains. The constipation is always complete, neither fæces nor flatus passing: the bowels may sometimes act once after the strangulation has occurred from that portion which lies below the seat of constriction, but they cannot, of course, empty themselves thoroughly, nor from above the strangled part.

Vomiting usually sets in early, and is often very severe and continuous, with much retching and straining; at first the contents of the stomach are ejected, with some bilious matters, but afterwards the vomiting becomes fæculent or stercoraceous. The cause of fæculent vomiting has usually been supposed to be an inverted peristaltic action of the intestines. Brinton, however, opposed this time-honoured view, maintaining that the peristaltic action continues direct and causes a peripheral downward current as far as the obstruction, from which point a central upward current returns the contents of the intestine towards the stomach, but the evidence supporting this theory is far from conclusive. The quantity brought up is often very large in amount, and consists not only of the normal contents of the intestine, but of an abundant secretion from the congested and irritated mucous membrane above the obstruction. It is greatly increased in quantity should the patient have taken a purgative. In cases of prolonged obstruction it is sometimes mixed with black shreds of altered blood, indicating intense inflammatory congestion of the mucous membrane. The vomiting is attended by colicky and dragging pains about the navel. These symptoms are more severe in their character when the strangulation is acute, than when it is passive. They occur equally in the incomplete and the complete forms of hernia; indeed, it not unfrequently happens that the tumour may be so small as to have escaped observation, the occurrence of the above-mentioned symptoms being the first indication of the probable nature of the mischief. Hence, it is a rule of practice always to examine for hernia when called to a patient suddenly seized with constipation, vomiting, and colicky pains, even if told that no tumour exists.

After the strangulation has existed for some time the abdomen becomes distended and tympanitic with much pain and distress. The pulse becomes small and rapid, and perhaps intermittent; the tongue is dry and speedily becomes brown; the countenance is pale, anxious and dragged. The extremities become cold, congested and clammy, and the temperature falls below normal. When gangrene of the rupture takes place, hiccup usually comes on, with sudden cessation of pain in the tumour, and intermittent pulse, cold sweats, pallor, anxiety, rapid sinking of the vital powers, usually with slight delirium; and death speedily occurs.

Modifications of Symptoms.—The symptoms just described are those which are usually met with in strangulated hernia. They may, however, be modified in some important respects.

1. There may be little or no tension in a strangulated hernia, the tumour continuing soft and lax; this is especially the case when the hernia contains omentum, and in congenital herniæ when strangulated. It may occur also in the case of double herniæ on the same side, in consequence of the outer sac being empty, or merely filled with serum, and the posterior one being

protruded against this and strangulated, but its tension being masked by the lax state of the outer one.

2. Vomiting sometimes does not take place from first to last, there being at most a little retching ; at other times the patient vomits once or twice, and then there is no recurrence of this symptom so long as he remains quiet, and keeps the stomach empty; but, on moving or taking nourishment of any kind, even if fluid, it comes on again, and thus the Surgeon may *elicit* this symptom, should it be necessary in a diagnostic point of view. If opium has been freely administered there may be no vomiting or pain.

3. Extensive peritonitis, with copious effusion of a puriform liquid, may occur without any pain, and with but little tenderness and no elevation of temperature ; the anxiety of countenance and sharpness of pulse being the only symptoms that lead to a suspicion of its existence.

4. Death may result from exhaustion consequent on vomiting, without any sign of gangrene in the constricted portion of intestine.

Partial Enterocele.—In the year 1700 Littre, a celebrated anatomist and surgeon at Montpellier, described a new form of hernia first observed by himself, in which the strangulated portion was a pouch-like projection from the side of the intestine; the lumen of gut not being completely obstructed. In two of the three cases described by him the strangulated portion was evidently a congenital diverticulum from the ileum. According to Treves, who has collected over fifty cases of partial enterocele, including four under his own care, the first accurate description of strangulation of a portion of the circumference of the gut was given by Richter in 1778. He therefore suggests as a distinction that the strangulation of a diverticulum should be termed Littre's hernia and that of a portion of the circumference of the gut, Richter's. The terms "partial enterocele" and "strangulation of a diverticulum" would, however, be less likely to lead to confusion. From an analysis of 53 cases Treves states that partial enterocele is most common in femoral herniæ and consequently in women. It has been most frequently met with in old reducible herniæ of small size. The tumour is always small, and in nearly half of the recorded cases was not recognised during life. In 7 out of 38 cases of femoral hernia an enlarged gland lay over the sac, obscuring the diagnosis. The bowel engaged is almost always the ileum, but in three it was the jejunum and in one the colon. The proportion of the gut included varied from four-fifths to one-sixth; it was below a half in the majority of the cases. When more than two-thirds of the gut is strangulated the passage of fluids is arrested by the bending of the bowel; when less is implicated the lumen may remain partly free. It has been supposed that a partial enterocele arises primarily from adhesion of a portion of the intestine over the mouth of a small sac, and the gradual formation of a pouch-like projection, but there is little evidence to support this theory. In the 53 cases collected by F. Treves the symptoms were those of ordinary strangulated hernia in about one-third, and in some of these after death there was found not to be complete mechanical obstruction of the lumen of the bowel. In the remaining cases the symptoms were characterised by less intensity. In three there was persistent diarrhœa throughout the case ; in several the bowels responded to aperients ; in others flatus and fæces were passed from one to three days after strangulation had occurred. The vomiting was usually less frequent and severe, and in only six of the 53 cases was it distinctly fæculent. In almost all cases there was no distension of the abdomen. The gut was reduced by taxis in two cases only and both of these died rapidly from peritonitis. In four cases (three femoral and one inguinal) reduction *en masse* occurred. The mortality in this form of hernia is very high, amounting to 62·2 per cent., owing to the difficulty and delay in diagnosis, and the tightness of the strangulation. There is nothing special in the treatment of this condition.

Strangulated Omental Hernia has been described by some writers as giving rise to symptoms identical in character with those of strangulation of the gut, but of less intensity. That mere strangulation of omentum causes no serious symptoms is evident from the safety with which large masses can be included in a ligature and cut away. When, therefore, signs of obstruction occur and on operating only omentum is found in the sac, it may be that a small knuckle of gut has been reduced without being noticed or that the omentum is in some way dragging on the gut so as to occlude its lumen. A pure epiplocele is very rarely strangulated. When irreducible, omentum may become inflamed, possibly as the result of injury, and an abscess has been known to form in it, and in these cases the swelling of the protruded portion may lead to its partial or complete strangulation. In this condition there are signs of peritonitis ; the vomiting is never stercoraceous ; there is incomplete obstruction with pain in the hernia and in the abdomen. The skin covering the sac becomes red and swollen. If such a condition could be diagnosed the best treatment would be to cut down on and open the sac and then to remove the congested and inflamed omentum.

DIAGNOSIS.—The diagnosis of strangulated hernia requires to be made from the following conditions :—

1. **Obstructed Irreducible Hernia.**—In this there are no acute symptoms, and the rupture will generally be found to be a large one of old standing. It may become somewhat tense and swollen, but is not tender to the touch, and always presents a certain degree of impulse on coughing. There may be constipation ; but there is no vomiting, or, if there be any, it is simply mucous and bilious, consisting of the contents of the stomach. The speedy restoration of the intestinal action, by the treatment already indicated as proper in these cases, will remove any doubt as to the nature of the affection.

2. **Inflamed Irreducible Hernia.**—This is accompanied by great tenderness and pain in the tumour, with pyrexia, and some general peritonitis, and there is no vomiting ; or, if the patient have vomited once or twice, he does not continue to do so with the same degree of violence, or in the same quantity, as he would if it were the result of strangulation. Again, the constipation is not absolute and entire, but flatus and liquid fæces will usually pass.

3. **General Peritonitis conjoined with Hernia.**—Here the diagnosis is often extremely difficult, especially if the hernia be an irreducible one. In these cases, however, it may be observed that the peritonitis is most intense at a distance from the sac ; that there is little or no vomiting, or, if there be, that it is not stercoraceous ; and that the constipation is not complete, flatus or even fæces occasionally passing.

4. In **Double Hernia,** one tumour may be strangulated and the other not, though irreducible. In these circumstances, it may at first be a little difficult to determine which one is the seat of constriction. This, however, may be ascertained by observing greater tension and tenderness about the neck of the strangulated than of the unconstricted hernia.

5. The co-existence of **Early Pregnancy,** or a **threatened Miscarriage**, may obscure the diagnosis, the Surgeon possibly being in doubt whether the vomiting is dependent on the state of the uterus or on the strangulation of the hernia. Here it may be stated generally that the vomiting of pregnancy never becomes stercoraceous; and that constipation is not complete, flatus if not fæces passing.

Besides these various conditions of hernia, which may be confounded with strangulation, there are other tumours which may be mistaken for this disease; but these we shall have to consider when speaking of the special forms of hernia.

TREATMENT.—The treatment of strangulated hernia is one of the most important subjects in surgery. The object to be accomplished is the removal of the constriction from the strangled hernial tumour. This is effected either by the Reduction of its Contents by Taxis; or by the Division of the Stricture.

Taxis.—The reduction of the hernia is effected by the employment of the taxis, by which is meant the various manual procedures employed in putting the rupture back. The taxis, when properly performed, is seldom attended with any serious consequences to the patient. I have never seen it followed by death; and out of 293 cases of hernia reported by Luke, as having been reduced by taxis in the London Hospital, none died. In the Reports of University College Hospital one fatal case is recorded in which death from ulceration and perforation of the gut at the seat of stricture followed reduction by taxis, and another in which death occurred from enteritis with profuse diarrhœa, followed by collapse. It is not unfrequently followed, however, by a rather sharp attack of peritonitis, which might probably, in some instances, prove fatal; in one instance, I have seen it followed by very abundant hæmorrhage from the bowel, probably owing to the rupture of some of the congested vessels of the strangled portion of the gut. In using the taxis, great care should in all cases be employed, and no undue force should be had recourse to. No good can ever be effected by violence: the resistance of the ring cannot be overcome by forcible pressure; and a vast deal of harm may be done by squeezing against it the tender and inflamed gut, causing this to overlap, and thus to be bruised, or even perhaps torn. The taxis should not be prolonged beyond half an hour; if it be properly employed for this time, the hernia, if reducible, will probably go back. If it be applied, as it often and very improperly is, for a lengthened period, and by several Surgeons in succession, the protruded part becomes ecchymosed, irritated, and disposed to inflammation; and the chances of recovery after a subsequent operation are much lessened. If taxis have been fairly and fully used by another Surgeon, it is better not to repeat it. When the parts are much inflamed, or if there is reason to fear from the duration of the strangulation or from the symptoms, that gangrene has occurred, the taxis should never be employed; as the putting back of the mortified gut into the abdomen would necessarily be fatal.

In using the taxis, it should be borne in mind that there are two obstacles to overcome; the resistance of the parts around the ring, and the bulk of the tumour. The first may be somewhat lessened by relaxing the abdominal muscles, and consequently diminishing the tension exercised upon the tendinous apertures and fasciæ of the groin. In order to effect this, the patient should be placed in a proper position, the body being bent forwards, the thigh adducted, and semi-flexed upon the abdomen; the Surgeon may then, by employing steady pressure on the tumour, endeavour to squeeze out some of the flatus from the strangled portion of intestine, and thus to effect its reduction. In doing this, the neck of the sac should be steadied with the fingers of the left hand: whilst, with the right spread over the tumour, the Surgeon endeavours to push it backwards, using a kind of kneading motion, and sometimes in the first instance drawing it slightly downwards, so as to disentangle it from the neck of the sac. The direction of the pressure is important; it should always be in the line of the descent of the tumour. These means may be employed as soon as the patient is seen by the Surgeon, when, by steadily carrying on the taxis for a few minutes, he will perhaps hear and feel a gurgling in the tumour, which will be followed by its immediate reduction. If the patient be thin, and the outline of the aperture through which the hernia escapes tolerably defined, the protrusion may be reduced, after failure of the taxis in the ordinary way, by passing the tip of the finger or the nail under the edge of the ring, and pulling this firmly and forcibly on one side, so as to steady and at the same time dilate it, pressure being kept up on the tumour with the other hand. This manœuvre can be practised with more facility and success in femoral hernia, where the upper edge of the saphenous opening is sharply defined, but may also successfully be had recourse to in inguinal and umbilical protrusions. In some cases reduction appears to have been facilitated by placing the patient on his head and shoulders, and raising the body in the vertical position whilst the taxis was being employed. Should, however, reduction not ensue, it will be desirable to have recourse at once to further means, the object of which is, by relaxing the muscles and lessening the bulk of the tumour, to enable the hernia to be reduced.

Auxiliary Measures.—The means to be employed must be modified according to the condition of the strangulation, whether it be of the active or of the passive kind. If it be active, the patient should at once be put fully under the influence of an anæsthetic. Ether is at the present time usually given, but in some cases it fails to produce perfectly muscular relaxation, and chloroform may then be substituted. When the patient is fully anæsthetized, taxis may be tried once again. Should it still fail, operation must be immediately proceeded with. No good can possibly come of delay in these cases, and repeated attempts at taxis should be carefully avoided. If the hernia do not admit of reduction in the early stage of the strangulation, it will necessarily be much less likely to do so when the parts, squeezed and bruised much by manipulation, will have had their congested condition greatly increased. Should no anæsthetic be at hand, the patient may be put into a hot bath, where he may remain for twenty minutes or half an hour, or until he feels faint; and, whilst he is in the bath in this condition, the taxis should be employed. If it do not succeed, he should be taken out, and wrapped up in blankets while an anæsthetic is being procured.

When the strangulation is of a passive character, supervening gradually in an old inguinal or umbilical hernia, and occurring in feeble or elderly people, other measures may, in exceptional cases, be adopted with the view of lessening the bulk of the tumour; which, rather than the tension of the parts, offers the chief object to reduction. In such circumstances, especially when the tumour is large and not very tense, the hot bath has a tendency to increase any congestion that may already exist in the hernia; I have in more than one case seen a strangulated rupture enlarge considerably after the employment of the bath. In such cases, more time may safely be spent in attempts at reduction than in very acutely strangulated herniæ. It is a useful practice to commence the treatment by the administration of a large enema; which, by emptying the lower bowel, will alter the relations of the abdominal contents, and may materially facilitate the reduction of the tumour. The best enema is one of gruel and castor-oil, with some spirits of turpentine added to it; it should be injected through a full-sized tube, passed high up into the gut, and with a moderate degree of force. In administering it, care must be taken that no injury be done to the bowel. It would scarcely be necessary to give such a caution as this, were it not that I was summoned, some years ago, by two very excellent practitioners, to see a woman with strangulated hernia, to whom an enema of about two quarts of tepid water had been administered; and as this had not returned, and did not appear to have gone up the bowel, they suspected that it must have passed out of the rectum into the surrounding areolar tissue. As the patient, however, did not seem to be suffering from this cause, and as the symptoms of strangulation were urgent, I operated on the hernia. Death suddenly occurred, apparently from exhaustion, in about eight hours; and, on examining the body, it was found that the rectum had been perforated, and the fluid injected into the meso-rectum, separating the gut from the sacrum, whence it had extended into the general subperitoneal areolar tissue, which contained a quantity of the liquid; some of the water appeared to have entered the peritoneal cavity also.

In the large herniæ of old people, more particularly the umbilical, in which there is a good deal of flatus, after the enema has been administered, a bladder of ice may be applied for three or four hours with excellent effect. Chloroform may then be given, and the taxis employed under its influence.

After taxis has been fairly employed for a sufficient time, and has not succeeded in reducing the hernia, the operation must be proceeded with. There are few Surgeons who will not at once acknowledge the truth of the remark of the late Hey of Leeds—that he had often regretted performing this operation too late, but never having done it too early. It is true that cases have been recorded, in which after four or five days of treatment the hernia has gone up; but it is very rare to meet with such cases in practice; and, in all probability, in delaying the operation in the hope of finding one such case, the lives of dozens of patients would be sacrificed. Luke has shown, as the result of the experience at the London Hospital, that the ratio of mortality increases in proportion to the length of time during which the strangulation is allowed to continue. Of 69 cases of strangulated hernia operated upon within the first 48 hours of strangulation, 12 died, or 1 in 5·7; whilst of 38 cases operated on after more than 48 hours had elapsed, 15 died, or 1 in 2·5. Indeed, one chief reason of the greater mortality from operations for hernia in hospital than in private practice, probably arises from the fact that much valuable time is frequently consumed before assistance is sought, or in fruitless efforts to reduce the swelling before the patient's admission. Not only is time lost in this way, but the bowel is often bruised and injuriously squeezed, so that inflammation is more likely to follow reduction. Moreover, at the present time the improved methods of treating wounds, especially those implicating the peritoneum, have so far diminished the dangers of the operation that the great reason for hesitation has been removed. The mortality in operations for strangulated hernia performed within twenty-four hours of the descent of the gut, with antiseptic precautions, or even with common attention to cleanliness, is so small, that it may be said to be almost inconsiderable.

Persistence of Symptoms after Reduction.—After the reduction of the hernia, the symptoms of strangulation may continue unabated. This untoward occurrence may arise from six distinct conditions: 1. The hernia may have been reduced in mass (see p. 835, Vol. II.). 2. An internal strangulation has existed within the sac, the taxis having overcome the external stricture, but failing to influence that within. 3. The gut may have been so severely nipped or strangulated for so long a time, that as soon as the constriction of the vessels is relieved, the phenomena of acute inflammation manifest themselves, with complete arrest of peristaltic movement. This condition, as before stated, may end in gangrene. 4. The sac may be of an hour-glass shape, lying partly within the abdomen and partly outside, and in the apparent reduction the gut may have been merely squeezed from the outer part of the sac into that lying within the cavity of the abdomen. 5. A second hernia may exist in a state of strangulation, which has escaped detection. 6. Rushton Parker has recorded a case in which apparent reduction was effected by merely forcing the contents back from a small knuckle of gut uniformly adherent by recent adhesions to the sac.

The diagnosis of those several conditions may possibly be made by attention to the following points. In the *reduction in mass* the tumour has slipped up without any gurgle; the canal is very open, and no trace of sac can be felt in it, but a rounded tumour, possibly at the upper part, on coughing. In the case of *internal adhesions* there will have been no gurgling, but the canal is still filled by the sac; the abdominal apertures are not preternaturally patent and distinct. In the case of *extreme nipping* and consequent inflammation and paralysis of a portion of the gut, gurgling will have been felt and heard in effecting the taxis, which does not happen in either of the other conditions, and the symptoms of intestinal obstruction will not be quite complete. The vomiting will lose its stercoraceous character, and probably some flatus will pass. An *hour-glass sac* is met with only in old inguinal herniæ, and appears to arise from a partial reduction in mass. Four cases of this kind have occurred in University College Hospital in the last twelve years. In each apparent reduction was easily effected, with slight gurgling. The protrusion readily re-appeared, and was easily put back again. The nature of the case was recognized only after operation performed for persistence of symptoms in three cases, and after death in the fourth. In the case of the *co-existence of a second hernia* in a state of strangulation, the cause of the continuance of the symptoms may be ascertained by careful examination of the abdominal walls. It is especially the co-existence of a small femoral with a large umbilical or inguinal hernia that is apt to be overlooked. This I have seen happen in a very fat person. A man was admitted into University College Hospital with strangulated inguinal hernia. It was reduced by the house-surgeon, but the symptoms persisted, and the patient died unrelieved, there being no indication for operation. After death a very small piece, half a knuckle, of intestine, was found strangulated in the crural canal of the same side. The patient being extremely fat, this strangulation was not detected, and could not be recognized during life. The folds of the groin should be very carefully examined in all these cases.

The **Treatment** of these different conditions is full of anxiety and difficulty to the Surgeon. If the symptoms are definitely unrelieved by the apparent reduction, especially if stercoraceous vomiting continue with undiminished severity for some hours, the proper practice is to cut down upon the sac. Should the hernia have been reduced *en masse*, no sac will be found in the ordinary situation, but by freely exposing the ring it may be brought into view and drawn down. It should then be opened and dealt with as in an ordinary case of hernia. Should the hernia not have been reduced in mass the sac should be opened, and possibly a small knuckle of gut may be found gripped at the inner ring, which, if not gangrenous, may be reduced, but should the sac be empty the treatment must vary with the form of hernia. If it be inguinal the wound may be enlarged upwards, and an examination made with the view of discovering a band or an adhesion near the neck of the sac, by the division of which the obstruction may be relieved. If nothing be found the coil of intestine near the neck of the sac may be drawn out and examined, and if it be found to be gangrenous may be attached to the edge of the wound, and an artificial anus may be allowed to form, which may be subsequently cured by operation. In the case of a femoral hernia the wound cannot be conveniently extended upwards so as to open the abdominal cavity. If, therefore, it be determined to explore the inner aspect of the ring, this may be done by an incision at the outer border of the rectus or in the middle line. From an incision in the middle line it is possible to examine both inguinal and femoral, and even the obturator openings without difficulty. If nothing be found the abdominal wound may be closed and the femoral left open, or in the case of an inguinal hernia the extended incision may be closed at its upper part, and the chance thus be given to the patient of the formation of an artificial anus or the sloughing of the strangulated or badly nipped knuckle of intestine; a result that I have more than once witnessed about the fourth or fifth day, the patient ultimately recovering.

In some cases, where the nipping of the strangulated intestine has been severe, yet not sufficient to arrest permanently the peristaltic action or to destroy its vitality, constipation and retching, with nausea, may continue; and the tumour, if the hernia have been small and deeply seated (more particularly if femoral), may continue to be felt, though less tense than before; consisting simply of the thickened and inflamed sac, with serous fluid in it. In these circumstances, we must be careful not to operate. I have, on two or three occasions, seen an empty sac operated on to the annoyance of the Surgeon and danger of the patient. The mistake may be avoided by observing that the symptoms gradually lessen in severity by waiting, the vomiting if it continues is no longer stercoraceous, the tympanites subsides, and the abdomen becoming flat and supple.

The length of time during which the congested condition of the bowel will continue after reduction, is very considerable. In a case of strangulated femoral hernia under my care, reduction was effected, but, strangulation recurring at the end of twelve days, an operation became necessary, and the patient died on the eighth day after it, or the twenty-first from the first strangulation. On examination, the small intestine was found congested in two portions, each of which was about eight inches in length; several feet of healthy gut intervening between them. One of these lay opposite the wound, and was evidently the intestine that was last strangulated. The other was altogether away from the seat of operation, but was equally darkly congested, being almost of a black colour, and was clearly that portion which had been constricted some time previously, and which, although twenty days had elapsed, had not as yet recovered itself.

When a second strangulated hernia exists it, of course, must either be reduced by the taxis, or the operation practised on it.

Acute Catarrhal Inflammation of the Mucous Membrane of the intestine or **Acute Enteritis** occasionally follows reduction of a strangulated hernia whether by taxis or by operation, and may prove fatal. In this condition the vomiting continues, but alters its character, being no longer stercoraceous but often very abundant and watery, with much mucus and shreds of blackened blood floating in it. At the same time there may be profuse diarrhœa unaccompanied by any marked pain, the stools being dark and very offensive. Unless this condition be relieved by treatment collapse speedily sets in, the extremities become cold and congested, the pulse fails, and death soon follows. Acute enteritis may possibly occur as the result of prolonged obstruction, but it is far more commonly due to the administration of powerful purgatives before the nature of the case was ascertained. The best treatment is the administration of a mixture containing a sixth of a grain of morphia and ten grains of nitrate or carbonate of bismuth every four hours. At the same time no solid food must be allowed. Milk and soda-water, barley water, arrowroot, or carefully prepared chicken-broth may be given. Beef-tea is apt to increase the diarrhœa. Brandy is frequently very useful, both as a stimulant and in arresting the diarrhœa.

OPERATION FOR STRANGULATED HERNIA.

All operations for hernia should be performed with efficient antiseptic precautions. The Surgeon and his assistants must first carefully clean their hands (Vol. I., p. 317), and the sponges and instruments must be disinfected as already described (Vol. I., p. 39). The skin for some distance around the seat of the incision must be shaved, cleaned and disinfected. The carbolic spray, if at hand, may be used, as experience has abundantly proved that in an operation for hernia it never does any harm, and in the opinion of many excellent Surgeons it is an additional security against septic peritonitis; especially as in operations for hernia it is impossible to clean out the cavity should any blood or fluid from the sac find admission to it. If the spray be not at hand, the wound may be occasionally irrigated with a carbolic lotion (1 in 40) or perchloride of mercury (1 in 2000), or other antiseptic solution, care being taken that the fluid does not pass into the peritoneal cavity; a basin of carbolic acid lotion should be at hand, into which the Surgeon should dip his hands before introducing the finger into the abdominal cavity. Should a coil of intestine be unavoidably exposed for any length of time, it may be covered with a piece of linen rag soaked in a warm 1 in 40 solution of carbolic acid. If the patient be much collapsed, the extremities must be covered with warm blankets, and no more of the body exposed than is necessary.

The operation for strangulated hernia may be performed in two ways; either by opening the sac, exposing its contents, and dividing the stricture, wherever it is situated, *from within;* or it may be done by dividing the stricture *outside,* without opening the sac. In either case the great object of the operation, the division of the stricture by the knife, is the same; but the mode in which it is effected is different. We shall first describe the operation in which the sac is opened; afterwards that in which it is not; and then briefly compare the two procedures.

Operation in which the Sac is opened.—**Exposure of the Sac.**—The patient must be brought to the edge of the bed, or placed on a table of convenient height. The dissection of the hernial coverings in layers anatomically arranged is never done at an operation. The Surgeon dissects, or rather cuts, down to the sac, then turn aside the coverings as a whole, and divides the stricture. He proceeds as follows: An incision of sufficient length is made over the neck of the sac; this may be best done by pinching up a fold of skin, pushing the scalpel through its base with the back of the instrument turned towards the hernia, and then cutting upwards (Fig. 803). A linear incision is thus made, which may be extended at either end if necessary; the dissection is then carried through the superficial fascia and fat with the scalpel and forceps. If any small artery spout freely, it had better be tied at once, or seized in forcipressure forceps, lest the bleeding obstruct the view of the part in the subsequent steps of the operation. As the Surgeon approaches the sac, more caution is required, particularly if the subserous areolar tissue be dense, opaque, and laminated. The Surgeon must pinch this up with the forceps, make a small incision into it, introduce a director, and lay it open upon this, or on the finger (Fig. 804). If it be thin and not opaque, so as to admit a view of the subjacent parts, he may dissect it through with the unsupported hand. In this way he proceeds until the sac is reached, which is usually known by its rounded and tense appearance, its filamentous character, and by the arborescent arrangement of vessels upon its surface. In some cases the Surgeon thinks that he has reached the sac, when in reality he has only come upon a deep layer of condensed areolar tissue in close contact with it; here the absence of all appearance of vessels, the dull and opaque character of the tissue and its more solid feel, together with the absence of the peculiar tension

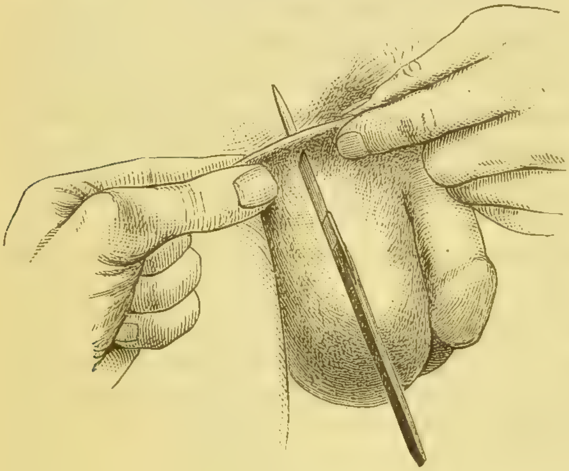


Fig. 803.—Operation for Hernia: Division of the Skin.

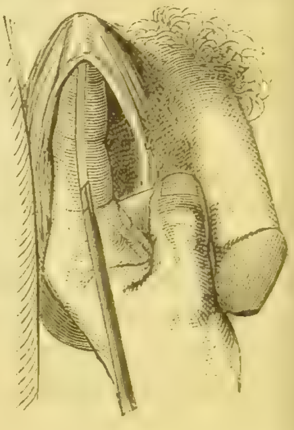


Fig. 804.—Operation for Hernia: Incision of Subserous Areolar Tissue.

that is characteristic of the sac, will enable him to recognize the real state of things. In other cases, the sac is so thin, and the superficial structures are so little condensed, that the Surgeon may lay it open in the earlier incisions before he thinks he has reached it. In these circumstances a portion of the intestine protruding might be mistaken for the sac. This dangerous error may be avoided by observing the highly polished appearance presented by the dark and congested gut, the absence of arborescent vessels, and the non-existence of any adhesions between its deeper portions and the tissues upon which it lies. If the sac be prematurely opened, the escape of fluid will indicate this; and if omentum protrude, the granular appearance and peculiar feel of this tissue will at once cause its recognition.

Opening the Sac.—The sac, having been exposed, must be carefully opened; this should be done towards its anterior aspect; and, if it be a small one, at its lower part. It may best be done, if the sac be not very tense, by seizing a portion of it between the finger and thumb, and thus feeling that no intestine is included; a small portion of it is then pinched up by the forceps, and an opening is made into it by cutting upon their points with the edge of the scalpel laid horizontally. If the sac be very tense, it cannot be pinched up in this way, and then it may best be opened by introducing the point of a fine hook very cautiously into its substance, raising up a portion of it in this way, and then making an aperture into it. There is little risk of wounding the gut in doing this; for the tension of the sac arises from the effusion of fluid into it, which will be interposed between it and the gut. In these cases, the fluid sometimes squirts out in a full jet, and occasionally in a very considerable quantity. I have seen at least a pint of slightly bloody serum escape on opening the sac of an old inguinal hernia which had become strangulated. Most frequently, however, there is not more than from half an ounce to an ounce; and sometimes the quantity is considerably less than this. If this fluid be clear and transparent, of a yellow tint like serum, it is a good sign, as probably no great amount of congestion has taken place. If reddened by extravasation of blood, it is an evidence of increased congestion; and the deeper the discoloration, the browner, the more muddy the fluid, the greater probably has been the change induced in the strangled parts by the congestion or inflammation resulting from the stricture. In some instances scarcely any fluid exists; and then it becomes necessary to proceed with extreme caution in opening the sac, as the gut or omentum is applied closely to its inner wall. In such cases as these the sac is not unfrequently sufficiently translucent to enable the Surgeon to see its contents through it: and he should then open it opposite to the omentum, or to any small mass of fat which he may observe shining through it. The opening, when once made into the sac, may be extended by the introduction of a broad director (Fig. 805), upon which it is to be slit up to a sufficient extent to allow the examination of its contents.

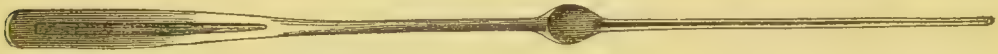


Fig. 805.—Broad and narrow Director on which the Sac may be divided.

Division of the Stricture.—The next point in the operation is the division of the stricture ; and this requires considerable care, lest injury be done to the neighbouring parts of importance, or the gut be wounded. Vessels and structures in the vicinity of the stricture are avoided by dividing it in a proper direction, in accordance with ordinary anatomical considerations, which will be described when we come to speak of the special forms of rupture. All injury to the intestine is prevented by introducing the index finger of the left hand up to the seat of stricture, insinuating the finger-nail underneath it, and dividing the constriction by means of a hernia-knife, having a very limited cutting edge (Fig. 806). If a director be used to guide the knife, the intestine will be in considerable danger, as the instrument may be slid under that portion of it which lies beneath the stricture ; or the tense gut, curling over the side of the groove, may come into contact with the edge of the knife. These accidents are prevented by using the finger as a director, and slipping the hernia-knife (which should not have quite so long a probe-point as those usually made) along the palmar surface of the finger, upon its flat side (as represented in Fig. 807) : the finger serves to keep the bowel out of the way, and detects any part that may be interposed between the edge of the knife and the stricture.

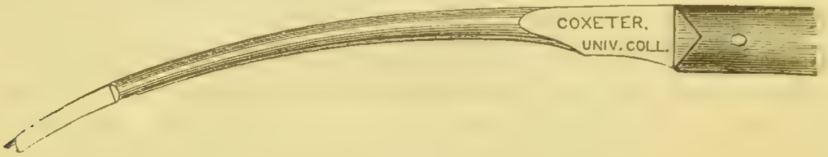


Fig. 806.—Hernia-knife.

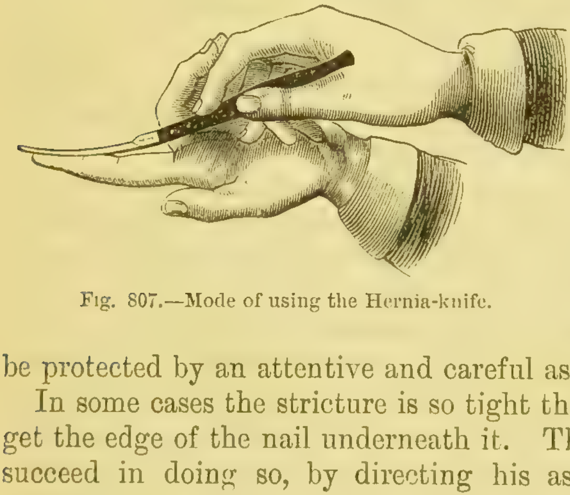


Fig. 807.—Mode of using the Hernia-knife.

During the division of the stricture, the protruding portions of intestine must be protected from the knife. The operator may spread his left hand over them in such a way that they cannot be touched by the edge of the instrument : or they may be protected by an attentive and careful assistant.

In some cases the stricture is so tight that it is at first almost impossible to get the edge of the nail underneath it. The Surgeon, will, however, generally succeed in doing so, by directing his assistant to draw down the coil of intestine, so as to loosen it, as it were, from underneath the stricture ; he will then usually succeed in passing his finger up in the middle of the coil, where the mesentery lies. As soon as the blunt end of the hernia-knife has been passed under the stricture, its sharp edge must be turned up, and the constriction divided in a proper direction, to a very limited extent, from one-eighth to a quarter of an inch.

Reduction.—The intestine and omentum, having been examined, must be dealt with according to the condition in which they are found : as will be subsequently described. If these structures be sufficiently healthy to admit of reduction, the intestine should first of all be replaced. This must be done by pushing it back with as much gentleness as possible, and chiefly by using the index fingers. When it has slipped up into the abdomen, the omentum must be returned in the same way. Care should be taken that the margins of the sac are firmly held down by means of a pair of forceps; lest it, together with its contents, be returned *en masse*, the stricture being undivided. After reduction, the Surgeon should pass his finger through the neck of the sac, and feel that all is clear.

Treatment of the Sac.—As a general rule, the operation should be completed by closing the neck of the sac, and, if possible, the ring, as in the radical cure of a reducible hernia. The details of this part of the operation vary with the variety of the rupture, and will be described with the special herniæ. There are, however, many exceptions to the rule. It may happen that the Surgeon is obliged to operate without the means of carrying out efficient antiseptic treatment; it is wiser then not to attempt a radical cure. If the patient be much exhausted, or be very old and feeble, or suffering from bronchitis, the operation should be concluded as quickly as possible, as the prolonged administration of the anæsthetic and exposure necessitated by attempting a radical cure might turn the scale against him. Lastly, if there is the slightest doubt as to the vitality of the gut the ring should not be closed, as should gangrene or ulceration occur after reduction, the patient's only chance of life lies in adhesion of the damaged gut to the ring, and in the formation of an artificial anus at the wound. The experience of the last few years has clearly shown that in properly selected cases the patient's danger is not increased by concluding the operation with a radical cure. If no means be taken to close the neck the opening in the sac heals readily under the pressure of the dressing, but obliteration by adhesion of its sides rarely occurs, and consequently the hernia returns when the wound is healed.

Treatment of the Wound.—After the operation is completed, whether the sac be removed or not, the wound must be brought together with sutures and a small drainage-tube inserted at the lower angle; it is then dressed, on ordinary principles, with some form of antiseptic dressing. Carbolic gauze, iodoform wool, salicylic wool, or any other efficient antiseptic material may be used. It must surround the wound for some distance, and a pad of the dressing should be placed over the abdominal opening to prevent the protrusion of the hernia during a fit of coughing or a muscular effort. The dressing must be secured by a bandage, over which a single turn of elastic webbing may be applied, passing over the abdominal opening to act as a truss. Care must be taken, that although the dressing is firmly applied undue pressure is not exerted, lest it interfere with drainage and prevent the union of the wound. This is particularly necessary if carbolic gauze be used, as the pad is apt to cake into a solid mass, if the material be not of the best quality. In the absence of other dressings a pad of lint soaked in carbolic oil (1 in 10), or simple dry lint or cotton-wool may be used. Water dressing should always be avoided. In most cases the wound heals by the first intention. Should suppuration occur the stitches must be removed and a light antiseptic dressing be applied, lest the pus, not finding a ready outlet, may either be diffused between the muscular planes of the abdominal wall, or return into the peritoneal cavity, exciting inflammation of it,—a result which I have more than once seen occur.

After-Treatment.—The patient should be kept quiet in bed; with the leg on the affected side bent over a pillow. From 30 to 40♏. of laudanum may then be given, or $\frac{1}{4}$ to $\frac{1}{3}$ gr. of morphia hypodermically. If the strangulation has been of very short duration—under 24 hours—and the gut but little congested, the patient may be left without further medical treatment until the bowels act by themselves, unless this be delayed for five or six days, when a castor-oil and gruel enema may be given. In all cases in which the strangulation has been of longer duration and more severe the bowels must be kept confined by small doses of opium till the fourth day at least. The opium may then be discontinued if there is no abdominal tenderness or other bad symptom, and the bowels allowed to act naturally. If they do not act before the end of a week and the patient is well in other respects, an enema may be given. It is of very great importance not to administer any purgatives. If the mechanical obstruction has been removed the bowels will be sure to recover their proper functions ; though, in consequence of the gut having been severely constricted by the pressure of the stricture, it may require to be left quiet for a few days before it can recover its peristaltic action. The administration of purgatives, by still further irritating it, will increase the risk of inflammation, and will probably do much harm. The patient, of course, must be kept upon the simplest and most unirritating diet—indeed, he should be allowed only barley-water and ice for the first day, and afterwards some beef-tea or chicken-broth ; milk should be avoided, as it coagulates in the stomach and is not easily digested. No solid food must be given till the bowels have acted, and all risk of peritonitis has passed.

The result of the operation for strangulated hernia is greatly influenced by the age of the patient ; being very much more favourable in the earlier than in the later periods of life. Bronchitis with emphysema is a very serious complication and not uncommon, the strangulation being often due to the cough. It is frequently aggravated to a fatal degree by the anæsthetic and the exposure during the operation. In these cases chloroform should be used in preference to ether. Obesity, also, has a very unfavourable effect. The depth of the wound in fat people adds to the difficulty of drainage and the discharges, if allowed to decompose, readily soak into the sub-peritoneal cellular tissue, and give rise to diffuse cellulitis with sloughing.

ACCIDENTS AND MODIFICATIONS OF THE OPERATION.—The operation having been thus described, we have next to consider in detail certain accidents attending it, or modifications which may be required ; such as Peritonitis, Acute Enteritis, the Management of the Intestine according to its conditions, the Management of Adhesions and of the Omentum, Wounds of the Intestine and of Arteries, Sloughing of the sac, Artificial Anus, and Fæcal Fistula.

Peritonitis after Operation.—The great danger to be apprehended after operations for hernia is the supervention of *diffuse peritonitis.* This very rarely exists at the time of the operation. In a considerable proportion of cases it arises from the introduction of septic matter into the cavity of the abdomen from the wound either at the time of the operation or at a later period should septic suppuration take place. In other cases it is dependent upon the condition of the gut at the time it is reduced. Even if it be actually gangrenous it may become rapidly surrounded by firm inflammatory exudation and diffuse inflammation may thus be prevented. More commonly this fails, the inflammation extends more widely, the quantity of the exudation becomes so great that the healthy part of the peritoneum cannot absorb it (see p. 883, Vol. I.); septic changes then take place in the accumulated fluid; the irritating products are diffused widely and general peritonitis results. When the gut is gangrenous, and probably if it be very acutely inflamed as the result of long strangulation, the surrounding inflammation of the peritoneum may assume a septic form, the infection taking place from within the gut. The first cause can be obviated by the use of antiseptics during the operation, but it is evident that these can have no influence when the source of infection comes from within the gut. The symptoms of peritonitis may assume two distinct forms, being active and acute, and passive or latent.

Acute Peritonitis is commonly met with in strong and robust people, otherwise healthy, who are the subjects of the operation. It presents the ordinary symptoms of acute inflammation of the peritoneum. There is tenderness of a diffused character, with lancinating pains. The patient lies on his back, with his knees drawn up, has an anxious countenance, a quick, hard pulse, a dry tongue, and much inflammatory fever; the respiration is principally thoracic, and tympanites soon comes on. The bowels are usually constipated, though sometimes irritated. Vomiting usually forms a marked symptom. The *Treatment* of this form is best conducted by the administration of opium. A pill containing gr. j of opium may be given every fourth or sixth hour, and hot fomentations should be applied to the abdomen. The patient must be confined to barley-water, milk, and ice. If the inflammation subsides, the constipation which is occasioned by it will be relieved without purgatives. The tympanites may best be removed in some cases by the passage of a long tube up the rectum. If this fails, and the distension is very great, a turpentine enema may be tried. As a last resource the intestines may be punctured with a fine hollow needle or a trochar.

Latent or Passive Peritonitis occurs chiefly in old people, or in weakly subjects, and is especially apt to follow upon inflammation of the omentum and its consequent suppuration. In other cases it follows the reduction of inflamed or gangrenous gut. More commonly it is the consequence of the extension of septic inflammation from the wound to the peritoneum. This form of inflammation is very apt to occur in overcrowded or unhealthy hospitals, and is prevented by the same means, hygienic and local, as pyæmia, septicæmia, and the allied diseases. It usually proves rapidly fatal, the patient being poisoned by absorption of the products of the unhealthy process; dying in fact of acute septic poisoning. In some instances, it sets in without the appearance of any marked local symptoms of inflammation, such as pain or uneasiness in the abdomen; but, two or three days after the operation, the patient becomes depressed, with a quick and weak pulse, an anxious countenance, a tumid and tympanitic abdomen, and rapid sinking of strength. In the majority of cases, however, some of the ordinary local signs of peritonitis are present. After death, the abdominal cavity will be found to contain a quantity of turbid serous fluid mixed with flakes of lymph; in many instances in such quantity as to give it a puriform appearance, and not unfrequently matting together the coils of intestine. In the *Treatment*, it is necessary to support the patient, and in some instances even to administer stimulants, such as ammonia, the brandy-and-egg mixture, &c. Depleting measures of all kinds are quite inadmissible; and, indeed, the remedy that offers the most prospect of benefit to the patient is opium in full doses, one grain being given every third or fourth hour until some effect is produced upon the constitution. If there is great tympanites it may be treated as in the acute form above described.

Localized Peritonitis is of common occurrence. It is not characterized by any very evident symptoms beyond pain and tenderness at some point of the abdomen near the seat of the hernia. It is most commonly due to the condition of the gut when reduced, and is often conservative in character. Thus in a case in University College Hospital, in which the patient died six days after the operation from bronchitis and emphysema, the part of the intestine which had been nipped was found to be firmly adherent to the surrounding coils by recent inflammatory exudation. Opposite the seat of stricture was a small slough, about half an inch in diameter, affecting the whole thickness of the coats. It was already partly separated, and had the patient not died from other causes, would probably have been thrown off into the intestine, without fæcal extravasation, owing to the firmness of the surrounding adhesions. The presence of the signs of local peritonitis are of importance only as indicating the necessity of avoiding purgatives or even enemata, until they have passed off. The patient must be kept slightly under the influence of opium to maintain rest of the inflamed bowel till all tenderness has disappeared.

Acute Catarrhal Inflammation of the mucous membrane of the intestines, or **acute enteritis,** occasionally follows the operation for strangulated hernia, and has been already described (p. 817).

Management of Congested Intestine.—The condition in which the contents of the sac are found in a case of hernia, determines greatly the course which the Surgeon should pursue after division of the stricture. Most frequently the intestine is deeply congested, being of a reddish purple, a claret, or chocolate colour. This congested state must not be confounded with gangrene—a mistake which might happen if the Surgeon were to judge of the condition of the bowel by its colour only. However dark this may be, the gut cannot be said to be gangrenous so long as it is polished and firm, free from putrescent odour, and without a greenish tinge. In cases in which there is much doubt as to whether its vitality continues or not, it has been proposed to scarify its surface lightly with the point of a lancet. If blood flow from the punctures, this may be taken as a proof of the continuance of the vitality of the part. Such a procedure as this, however, is certainly attended by some degree of danger, and can seldom be required.

When the intestine is merely congested, however deeply, the rule is, that it should be returned into the cavity of the abdomen in the hope of its ultimately recovering. This it will generally do if it have not been too much handled after the sac has been opened ; but in some cases it will slough a few days after it has been reduced, and, the fæces being discharged through the wound, a fæcal fistula will be formed ; this may happen as late as the eighth or tenth day after the operation. In doubtful cases the wound should be left partly open and lightly dressed with some antiseptic material, no effort being made to close the neck of the sac with the idea of obtaining a radical cure.

Management of Tightly Constricted Intestine.—When the intestine has been very tightly nipped by a sharp-edged stricture, so that a deep sulcus or depression is left upon it, it seldom recovers, whether the whole of the coil of gut have been thus affected, or only a small portion of its diameter. It is remarkable how very quickly changes which are incompatible with life may ensue in a portion of gut that has been very tightly strangulated. I have known a coil of intestine, that had been but eight hours strangulated before the operation was performed, so tightly constricted as not to regain its vitality after reduction (Fig. 808). In such cases the patient usually dies of peritonitis in the course of a few days without the bowels having acted, all peristaltic motion having necessarily been annihilated at the injured point. On examination after death, the constricted intestine will be found to present all the appearances of *gangrene*, being of a black or ashy-grey colour, without having any flocculi of lymph deposited upon its surface, though these may be in abundance in the neighbouring parts. From the very unfavourable result of those cases in which there has been very tight nipping of the protruded bowel, a very cautious prognosis should be given; and, in reducing the gut after division of the stricture, care should be taken not to push it far back into the abdomen, but to leave it near the inner ring; so that, in the event of its ultimately giving way, there may be less risk of fæculent extravasation into the peritoneal cavity. In those cases in which the nipping has been very severe, the sulcus being distinctly marked, and the intestine excessively dark and congested, though not certainly gangrenous, it would, I think, be better to treat it as if it were so and, after dividing the stricture, to leave it outside the ring instead of returning it; the reduction of intestine in this state being almost invariably followed by fatal peritonitis.

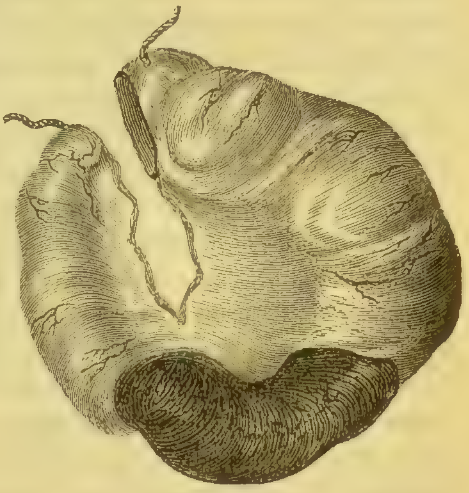


Fig. 808.—Gangrene of Intestine from Strangulation.

It is important to observe that it is not always possible to tell certainly whether the gut is past recovery or not. Intestine which has been so severely nipped, as to be unable to recover its vitality, and which will fall into a state of gangrene after being reduced, may not, at the time of its exposure, present the characters of putrescence; there is no fetor, no green or pulpy appearance, no loss of polish, nor separation of peritoneum; it is simply of a dark purple or maroon colour, and that it has been tightly nipped is evident from the sulcus upon it. There are no signs of gangrene, simply because sufficient time has not elapsed for putrefaction to set in. As, when a pile or nævus has been tied, though vitality be extinct in the part, some time must elapse before signs of putrescence manifest themselves, so it may be with a strictured gut.

Management of Gangrenous Intestine.—When the intestine is actually gangrenous, the integuments covering the tumour will be infiltrated, brawny, and duskily congested, and the structures immediately overlying the sac matted together; the sac will contain fetid dark-coloured serum or pus; and the softened, lacerable, or pulpy look of the protruded part, its loss of lustre, and peculiar greenish-black or dark-grey colour, will cause the nature of the mischief to be readily recognized. In the majority of cases there will be much constitutional depression, with clammy skin, tympanitic abdomen, and brown or black tongue; but in some instances I have known all these symptoms to be absent, and the condition of the patient to present no very unfavourable features. Some difference of opinion exists as to the proper line of practice to be adopted in such cases. Travers and Lawrence seem to think that the division of the stricture is unnecessary, or may even be injurious; while Dupuytren, A. Cooper, and Key (with whom I concur), advise that it should be done. The stricture should be divided in the usual way; a free incision should then be made into the protruded portion of bowel, which must be left unreduced, so as to allow the escape of fæces; and the wound left open and covered by a moist antiseptic dressing. In this way an artificial anus will necessarily be formed, through which the fæculent matter finds exit. The gut in the vicinity of the stricture is retained *in situ* by masses of plastic exudation, which prevent the peritoneal cavity from being opened. If the intestine should already have given way before the operation is performed, the stricture must be divided, and the part then left unreduced, care being taken to interfere as little as possible with any adhesions or connections lying inside the neck of the sac; though I fully agree with Key in thinking that the danger of disturbing them has been exaggerated.

When only a small portion of the bowel is gangrenous, the better plan is to return it just beyond the mouth of the sac, without laying it open; but it should not be pushed any distance into the cavity of the abdomen; the pressure of the surrounding parts will prevent extravasation. When the slough separates, it will probably be discharged into the cavity of the intestine; and the aperture resulting will be closed by the adhesions that extend between its margin and the abdominal wall.

During the last few years the operation of removing the gangrenous portion of the gut and uniting the intestine by suture, originally performed by Dieffenbach in 1836, has been revived and repeatedly performed by Billroth, Czerny, Juillard, Madelung, R. Parker, and others. Juillard in 1882 published 44 cases, collected from various sources, in which this operation had been performed; of these 23 died. These results contrast unfavourably with those of the same operation performed for the relief of an artificial anus or fæcal fistula, of which Juillard records 23 cases with 8 deaths. He therefore recommends that in all cases the gut should first be treated as above described, and the attempt to unite the ends delayed for two or three weeks. By this time the patient, if he survive, will have gained strength; the fæcal accumulation in the upper part of the gut will have been relieved, and the operation will altogether be performed under more favourable circumstances. If the attempt to remove the gangrenous gut be made at the time of the operation for relief of strangulation, the condition of the surrounding parts is in many cases most unfavourable, diffuse inflammation often extending for many inches around the sac. Under such circumstances the removal of the gangrenous gut would evidently be out of the question. The operation will be described subsequently with removal of portions of the gut for other causes.

Management of Adhesions.—This varies according to the condition of the bowel, and the nature and situation of the bands. As has just been remarked, if gangrene be present, especial care must be taken not to disturb any connections that have been formed about the neck of the sac, and which constitute the most effectual barrier against fæculent extravasation. When the adhesions are recent, consisting merely of plastic matter, in whatever situation they exist, they may readily be broken down with the finger or the handle of the scalpel, and the parts then returned. When of old standing, and dense, they must be dealt with according to their connections. Most frequently these adhesions occur in the shape of thickened bands, situated within and stretching across the neck of the sac. In other cases, they may be found either as filamentous bands, or as broad attachments, connecting the sac with its contents, and perhaps tying these together. When of a narrow and constricted form, and more particularly when seated in the neck of the sac, or stretching like bridles across its interior, they may readily be divided by a probe-pointed bistoury, or the hernia-knife. If they consist of broad attachments, they may be dissected away, by a little careful manipulation, from the parts in the inside of the sac; though, if the adhesions be very extensive and of old standing, it may sometimes be more prudent to dissect away that portion of the sac which is in connection with them, or even to leave them untouched, and the adherent intestine or omentum unreduced rather than to endeavour to separate them. They may, however, attach themselves in such situations that it becomes necessary to divide them; thus I have, in a case of congenital hernia, found it necessary to dissect away some very extensive adhesions that had formed between the omentum and the testicle, and indeed had almost completely enveloped that organ.

Internal Adhesions between the omentum and intestine or mesentery occasionally exist, consisting usually of rather firm bands stretching across from one part to the other, sometimes connected with the inner wall of the sac, but in other cases confined to its contents. As these bands may constitute the real stricture, continuing to strangulate the gut after the division of the structures outside and in the neck of the sac, they must necessarily be divided. This operation requires great care, lest the neighbouring intestine be wounded. It is best done by passing a director underneath, and cutting the bands through with a probe-pointed bistoury; or if this cannot be done on account of their connections, they must be seized with forceps, and carefully dissected off the gut. In a case of large inguinal hernia, containing both gut and omentum, on which I operated some years ago, I found, after dividing the stricture, and taking hold of the omentum in order to push back the intestine, that this could not be done. On drawing the mass well down, I found high up, in the part corresponding to the neck of the sac, a band like a piece of whipcord, stretching across from the omentum to the mesentery and firmly tying down the gut. On dissecting this through, the constricted portion of intestine subjacent to it sprang up to its full diameter, and was then very readily reduced.

Management of Strangulated Omentum.—The omentum may require to be treated in one of three ways: 1. It may be returned; 2. It may be left in the sac; 3. It may be cut off. The method of treatment must vary according to the state in which the omentum is found. If it be small in quantity, healthy in character though congested, and apparently recently protruded, not having undergone those changes that occur in it when it has been a long time in a hernial sac, it should be reduced.

If, however, its mass be very large, if it be hypertrophied, indurated, or otherwise altered in structure, or if it be closely adherent to the sac, at the same time that it is congested, Surgeons are agreed that it should not be returned into the abdominal cavity; as inflammation of it, *Epiploïtis*, will probably set in and terminate fatally with effusion into the peritoneal sac. So also, if the omentum be in large quantity, and have become inflamed in the sac, it should not be returned; as the inflammation in it is very apt to run on to a kind of sloughy condition of the whole mass. If gangrenous, it should of course not be reduced. When simply hypertrophied and adherent to the sac, but without evidence of inflammation, it may be left in the sac; but, in many of the cases of hypertrophied, and in all cases of inflamed or gangrenous omentum, the best practice consists in cutting off the mass, as recommended by Sir A. Cooper and Lawrence. If it be left in the sac, inflammation or sloughing of it will occur, and the patient will derive no corresponding advantage to the danger he will consequently run. *Excision* of the mass may be best done by enclosing the neck in a ligature and then cutting it off below this. The ligature may be of carbolized catgut or fine carbolized silk. If the mass be large it is better to divide it into several pieces, and to tie each separately. None of the ligatures should be cut short till all are tied, and the omentum cut away. The stump must then be reduced just within the ring, as the constriction of this may be arresting bleeding from an imperfectly secured vessel. If no blood flows out, the stump is drawn out again, and the ligatures cut short and allowed to retract with the stump of the omentum into the abdomen. If the omentum has suffered much from the strangulation, it must be drawn well down, so that the ligatures may be applied to a healthy part. If carbolized catgut or silk be not at hand, a strong double ligature of whipcord or silk must be passed through the neck and tied securely on each side, the mass below then being cut off. As a ligature of this kind would be a source of irritation if it were drawn into the peritoneal cavity, it must not be cut short, and its ends may be secured to a piece of plaster on the fore part of the abdomen, to prevent retraction of the stump of the omentum. I have in former times frequently employed this plan with excellent effect. The constricted stump of omentum sloughs away in a few days, and separates with the ligature. When this practice is adopted, the wound should not be closed, and must be lightly dressed. The quantity of omentum that is cut off varies considerably; the mass removed usually weighs from four to six ounces, but in some instances it may amount to a pound or more.

Sacs or **Apertures in the Omentum** are occasionally met with, in which a knuckle of intestine may become enveloped, or by the margins of which it may be strangulated. These envelopes of omentum around the gut, which have been especially described by Sir P. Hewett, may occur in all kinds of hernia, at least in the inguinal, the femoral, and the umbilical, and sometimes acquire a large size, completely shutting in the gut. They appear to be formed in some cases at least by the adhesion of the opposite edges of floating layers of omentum around a piece of intestine, which thus becomes included. It is of importance to bear in mind the possibility of their existence, and in all cases to unravel the omentum before removing it, lest it contain a knuckle of intestine, which might be wounded in the operation.

Cysts, usually containing pellucid serous fluid, straw-coloured or reddened, but sometimes filled with blood, are occasionally met with in the omentum. They appear to be formed in the same way as the sacs containing intestine just described, except that they are enclosed on all sides, their serous contents being merely exudations from the peritoneal lining of the cyst. They are globular, elastic, and closely resemble in form a knuckle of intestine, occasioning not a little embarrassment to the Surgeon; by a careful examination and unravelling, however, of the omentum, their true nature will be made out;

their fluid contents may then be discharged, and the omentum dealt with according to the rules already given.

Wounds of the Intestine may accidentally occur at two periods of the operation; either from the Surgeon cutting too freely down upon the sac, and opening this before he is aware of what he is about; or else, at the time of the division of the stricture, from a portion of the gut which lies beneath it getting into the way of the edge of the knife, and being nicked by it. The first kind of accident can happen only from a certain degree of carelessness; but it is not always so easy to avoid wounding the gut, when the stricture is so tight that the finger-nail cannot be slipped under it as a guide to the hernia-knife. In cases of this kind, a very narrow director must be used; and this is a most dangerous instrument, as, in passing it deeply out of sight under the tight stricture, a small portion of the gut may curl up over its side into the groove, and thus become notched by the knife as this is slid along it. This accident has happened to the most careful Surgeons. Lawrence relates two cases that occurred to him; and Sir A. Cooper, Cloquet, Jobert, and Liston have all met with it. It may be known to have occurred by the bubbling up of a small quantity of flatus and liquid fæces from the bottom of the incision. The *Treatment* of a wound of the gut must depend upon its size. When it is very small, resembling a puncture rather than a cut, the practice recommended by Sir A. Cooper should be adopted; viz., to seize the margins of the incision with a pair of forceps, and to tie a fine silk thread tightly round them, the ends of which should then be cut off, and the gut returned into the abdominal cavity. Such a proceeding as this does not appear to give rise to much, if to any, increase of danger. In a case that occurred to me many years ago at the Hospital, in which, owing to the excessive tightness of the stricture, only a very narrow director could be passed under it, the gut immediately above it was notched and opened by a kind of punctured wound; this was tied up in the way mentioned, and after the death of the patient, which took place on the fourth day after the operation from gangrene of the strangulated portion of bowel, the silk ligature was found to be completely enveloped in a mass of firm plastic exudation. If the wound be of larger size, it must be closed by Lembert's suture in the manner described in the chapter on Wounds of the Intestine (p. 888, Vol. I.). The gut must be very carefully cleaned with some antiseptic solution before being returned.

Wound of one of the Arteries in the neighbourhood of the sac may occur during the division of the stricture, either in consequence of some anomaly in the distribution of the vessel, or from the Surgeon dividing the parts in a wrong direction. This accident usually happens to the epigastric or to the obturator artery; and Lawrence collected fourteen cases in which it occurred. The result in these has been very various; in some the patients have died; in others, after much loss of blood, and consequent faintness, the bleeding ceased spontaneously. The proper *Treatment* would certainly consist in cutting down upon and securing the bleeding vessel. In the event of the Surgeon operating on a case of hernia, without having been able previously to satisfy himself as to its precise character, or if from any cause, in dividing the stricture, he have reason to dread the proximity of an artery, he may safely and readily divide the constriction with a knife that would not easily cut an artery; and he will find, if he blunt the edge of his hernia-knife by drawing it over the back of the scalpel, that it will still be keen enough to relieve the strangulation, whilst it will push before it any artery that may happen to be in the way.

Sloughing of the Sac is of rare occurrence, and, when it happens, is commonly attended by fatal results; it is not, however, necessarily so. It has twice happened in my practice; and in both cases the patient recovered. In an old woman on whom I operated for femoral hernia of very large size, the sac sloughed away, exposing nearly the whole of Scarpa's triangle with almost as much distinctness as if it had been dissected; but, although in much danger for a time from an acute attack of peritonitis, she ultimately recovered.

Artificial Anus and Fæcal Fistula.—When an aperture exists in the bowel by which the whole of the intestinal contents escape externally, the condition is denominated an *artificial anus*. When but a small portion so escapes, the greater part finding its way through the natural anus, a *fæcal fistula* is said to exist. The quantity of fæculent discharge necessarily depends upon the extent of destruction of the intestinal coats; and its character on the part of the gut that is injured. The escape takes place involuntarily, and is usually continuous.

This condition may occur in several ways. Thus the gut may be accidentally wounded during the operation, and the fæces may afterwards continue to be discharged through the aperture so made; or it may have been gangrenous, and have given way into the sac before the operation; or the Surgeon may have intentionally laid open a gangrenous portion of intestine, so as to facilitate the escape of the fæces. In some cases in which the bowel has been severely nipped, and is dark and congested, though it have not actually fallen into a state of gangrene, it may not be able to recover itself after its return into the abdominal cavity, but will give way in the course of three, four, six, or even ten days after the operation. In these cases, a small quantity of fæculent matter is first observed in the dressings; and gradually a greater discharge appears, until at last the fistulous opening is completely established. In such cases, it is of importance to observe that, although the bowel gives way within the peritoneum, the fæces do not become extravasated into the cavity, but escape externally. This is owing to the portion of the bowel that is nipped losing its peristaltic action, and consequently remaining where it is put back; whilst the parts in the neighbourhood inflame, throw out a coagulable exudation, and become consolidated to each other and to the parietal peritoneum, so as to include the gangrenous portion of the gut, and completely to circumscribe it. It is consequently of great importance, in cases of this kind, not in any way to disturb the adhesions that have formed between the sides of the aperture in the gut and the neck of the sac.

The *Pathology of Artificial Anus* is commonly as follows. The edges of the aperture in the gut become firmly adherent to the abdominal wall; and whether the whole or only a portion of the calibre of the intestine be destroyed, the apertures of the upper and lower end, though at first lying almost in a continuous line, soon unite at a more or less acute angle. These are at first similar in size, and present no material differences in shape or appearance; as the disease becomes more chronic, they gradually alter in their characters; the lower aperture, being no longer used for the transmission of fæces, gradually becomes narrower, until at last it may be almost completely obliterated; whilst the upper portion of intestine becomes dilated in consequence of there being usually some slight obstruction to the outward passage of the fæces.

The mesentery opposite the aperture becomes drawn out into a kind of prolongation or spur, the full importance of which was first pointed out by Dupuytren. This spur-like process projects between the two apertures, and, being deflected by the passage of the fæces, has at last a tendency to act as a kind of valve, and thus to occlude the orifice into the lower portion of the gut. The integuments in the neighbourhood of such an aperture as this usually become irritated, excoriated, from the constant passage of the fæces over them. In some cases, the mucous membrane lining the edges becomes everted, and pouting ; and, in others, a true prolapse of the gut takes place, large portions protruding. An artificial anus fully formed in this way never undergoes spontaneous cure. Besides this, which is the ordinary form of artificial anus, we must, I think, recognize at least two other varieties, both of which I have met with in practice. In one of these, the angle formed by the gut is adherent to the upper extremity of the sac which has been returned, and thus lies at some distance from the surface, so that the fæcal matter traverses a long channel before it reaches the external aperture. In the other variety the angle of the gut is fixed at a higher point within the abdomen, and the fæces find their way out through a channel bounded by agglutinated coils of intestine and layers of lymph. In both of these forms, there is a considerable distance between the external opening and the aperture in the gut. Thus, then, there are three forms of artificial anus, differing from one another according to the situation of the angle of the gut in relation to the external opening and to its connections.

When a *Fæcal Fistula* has formed, the condition of the parts is somewhat different. The aperture in the intestine consists of merely a small perforation in its coats, through which a quantity of thin fæculent matter exudes, giving rise to a good deal of irritation of neighbouring structures. In some cases, there are several apertures communicating with the gut, and extending through the skin. Fistulous openings of this kind not unfrequently undergo spontaneous cure after a few weeks or months.

Treatment.—If the aperture be merely a small one, with a narrow fistula leading into the gut, the chief inconvenience suffered by the patient often arises from the irritation of the skin around the opening by the continued moisture of the fæculent matter. In such cases the skin should be protected by means of zinc or boracic acid ointment or eucalyptus oil and vaseline spread on lint ; and the patient should wear a pad to restrain the discharge. By the pressure of this pad the aperture may sometimes be made to close. In other cases, the occasional application of the galvanic cautery or of a red-hot wire will induce contraction of its edges ; and in other instances, again, a plastic operation of some kind may be required. But I confess I have not usually seen much advantage result from such operations, which are often followed by erysipelas. As the existence of an artificial anus, by interfering with nutrition, commonly gives rise to considerable emaciation, it becomes necessary to support the patient's strength by a sufficient quantity of good and nourishing food ; this is of greater consequence the higher the fistula is, as the interference with the earlier stages of the digestive process, and the loss of nutritive material by the discharge of the chyme, is proportionally great. Spontaneous cure will occasionally take place, even though a perfect artificial anus exist. In a case under my care at the Hospital, a whole knuckle of intestine was gangrenous, and sloughed away, leaving an artificial anus, which discharged the greater part of the intestinal contents, but gradually contracted and closed without any local application or treatment beyond attention to cleanliness.

If the aperture become a permanent artificial anus, surgical means must be adopted in order, if possible to effect a cure. Many plans have been suggested for effecting this object. Mitchell Banks succeeded in curing one case by introducing a piece of thick india-rubber tubing, pushing one end up the ascending and the other down the descending tube. A piece of silk was attached to it and hung out at the artificial anus. The tube was kept in for a week at a time and inserted "twice or thrice." It was calculated that the continuous pressure of the tube would press back the spur-like process. The patient was completely cured in about two months, the opening closing without further operative interference. If this simple treatment fails, the two most important modes of cure are Dupuytren's operation and suture of the gut, with or without removal of a portion.

In Dupuytren's operation two important indications have to be fulfilled: the first is to diminish or destroy the projecting valvular or spur-like process, and thus to re-establish the continuity of the canal; and, after this has been done, the external wound may be closed, by paring its edges, and bringing them together with sutures.

The first object is accomplished by the *enterotome* (Fig. 809); this consists of an instrument something like a pair of scissors, with blunt but serrated blades, which may be brought together by acting upon a screw that traverses its handle. One blade of the instrument (*a*) is passed into the upper, the other (*b*) into the lower portion of the intestine; they are then approximated slowly, and fixed by means of the screw in such a way as to compress on each side the spur-like process (Fig. 810). Very gradually, day by day, this screw is tightened so as to induce sloughing of this projection, and cohesion of its serous surfaces. As this process goes on, the irritation caused by the instrument will occasion inflammatory exudation in the angle formed by the intestine, so that the peritoneum and mesentery become consolidated, and all opening into the peritoneal cavity is avoided. Should the spur-like process be accidentally cut through before the lymph is thrown out in sufficient quantity, the peritoneum would be opened, and death would probably ensue; hence

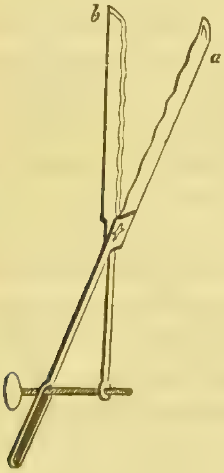


Fig. 809.—Dupuytren's Enterotome.

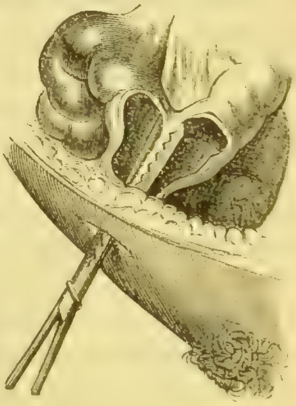


Fig. 810.—Enterotome applied.

the necessity for caution in this procedure. As soon as the blades of the instrument have come into contact, and the spur-like process has consequently sloughed away, the great obstacle to the closure of the artificial anus will be removed ; and the continuity of the canal being thus re-established, the lips of the external opening may be pared and brought together by sutures. In some cases, from the length of time that has elapsed—many years, possibly —the fistula continues permanently patent, and no treatment is available for its closure. Its existence is not incompatible with good general health. I have had two cases under my constant observation, in one of which, that of a woman about fifty years of age, the whole of the intestinal contents have been discharged for four years through an aperture at the umbilicus, in consequence of the sloughing away of a large coil of intestine in an umbilical hernia ; the other being that of a lady more than eighty, who has for upwards of thirty years had a fæcal fistula in the right groin, consequent on an operation for femoral hernia.

In the second method of operating adopted by Dittel, Billroth, Czerny, and many other Continental Surgeons, the gut is freely exposed and dissected away from its adhesions to the abdominal wall. This must be done with antiseptic precautions. The bowels must have been thoroughly emptied before the operation is commenced. The external opening must be carefully cleaned with some efficient antiseptic, and unhealthy granulation-tissue must be scraped away with a sharp spoon. The orifice of the gut must also be cleansed, and a small piece of sponge, which has been properly disinfected by carbolic lotion, may be pushed into the upper orifice to prevent the escape of any fæcal matter. The opening through which the gut protrudes must then be enlarged by an incision carried in the most convenient direction and the gut dissected away and drawn out. If the opening is on one side only and very small, it may be closed by sutures ; if large, the whole affected portion of the gut is cut away. The details of this operation are described later on, as they are identical with those practised in the removal of portions of intestine for other causes. The death-rate among the published cases in which this operation has been performed, is one in four ; so it must not be lightly undertaken. If the patient suffers merely from a fæcal fistula, which can be easily controlled by a pad, it would evidently be unjustifiable to submit him to the risk of such an operation. If, however, the patient is otherwise in good health, but suffering great inconvenience from the artificial anus, and other means have failed, the operation holds out a fair prospect of relief and may be undertaken.

Operation without Opening the Sac, or **Petit's Operation.**—The possibility of reducing a strangulated hernia without opening the peritoneum naturally suggested itself when it became known that the constricting structures are, in many cases, seated outside the neck of the sac, and as long ago as 1718 the operation was performed in this way by Petit. It was, however, but seldom practised until it was revived by Aston Key and Luke fifty years ago. At that time a wound of the peritoneum was always accompanied by danger to life from septic peritonitis, and there is no doubt that by avoiding opening the sac many lives were saved. The statistics collected by Luke clearly demonstrate this. In 84 cases operated on by himself the sac was opened in 25, and of these 8 died, while of 59 cases in which it was not opened only 7 died. The ordinary operation was at that time undoubtedly very fatal. Of

77 cases under the care of Sir A. Cooper, 36 proved fatal ; and of 545 recorded in the journals and collected by Turner 260 are reported to have died. It must not, however, be assumed that the higher mortality was due entirely to the wound in the peritoneum, for it must be remembered that every serious complication, such as gangrene of the gut, prolonged strangulation, reduction in mass, &c., necessitates opening the sac. Nor could the operation, without opening the sac, exclude peritonitis altogether, as in many cases the inflammation of the peritoneum starts from the injured portion of the gut after reduction and not from the wound. Unhealthy inflammation in the wound may also extend to the peritoneum even when the sac has not been opened. Making allowance for all this, however, there is no doubt that in former times it was wiser not to open the peritoneum if it could possibly be avoided. At the present time, with proper antiseptic precautions, a wound of the peritoneun is not regarded as being accompanied by any special danger, and the arguments in favour of Petit's operation cannot now be said to outweigh the objections to its performance. The two chief objections that have been urged against it are, first, that if the intestine be not seen it may sometimes be returned in a gangrenous condition, and secondly, that the gut may possibly be returned still strangulated by bands of adhesion or by inclusion in an omental aperture. There is no doubt that the latter of these conditions is extremely rare, and in the former the duration of strangulation and the symptoms would probably indicate that gangrene had commenced, but as the mere wound of the peritoneum, with proper precautions, is no longer regarded as adding in any way to the danger of the operation the possibility of their occurrence is sufficient to justify opening the sac in all cases. It may, however, happen occasionally that the Surgeon may be called upon to operate in an emergency without the proper means of ensuring asepsis being at hand, and under such circumstances I am decidedly of opinion that Petit's operation should be attempted in preference to opening the sac whenever the hernia has not been long strangulated and presents no signs of gangrene, and more especially when it is femoral or umbilical.

When an old irreducible hernia of considerable size becomes strangulated it is usually better to avoid opening the sac if possible, as the contents cannot be completely reduced, and owing to the difficulty in dressing such cases septic inflammation may follow terminating in fatal general peritonitis. In these cases, as Luke has pointed out, it rarely happens that the old adherent parts are seriously strangulated, but the whole mischief seems to be occasioned by the new protrusion, which is tightly nipped ; and if this can be liberated and reduced, the Surgeon has done all that need be accomplished. The evidence of the reduction of the recent protrusion, although the old adherent and irreducible hernia be left, is usually sufficiently clear ; the portion of gut returning with a slip and a gurgle, with considerable diminution in the general tension of the tumour.

The operation without opening the sac may be practised in all forms of hernia, but is much more readily done in some varieties of the disease than in others. It is especially applicable in cases of femoral hernia, in which the stricture is commonly outside the sac, as will be mentioned when speaking of that form of the disease. Of 31 cases of femoral hernia, operated on by Luke, the sac required opening in 7 only. In inguinal hernia it is not so easy to perform Petit's operation ; indeed, in the majority of cases the Surgeon will fail to remove the stricture in this way. This is owing to the constriction being usually seated in the neck of the sac, as is especially observable in congenital hernia. Of 20 inguinal herniæ operated on by Luke, the sac required opening in 13 instances.

Operation.—With regard to the mode of performing Petit's operation little need be said here, as it is precisely identical with the steps of the other operation up to the period of the exposure of the sac; except that, when it is not intended to open this, the incision should be placed more directly over its neck. The stricture, if situated outside the sac, will then be found either in some of the tendinous structures surrounding it, or else in the subserous areolar tissue lying upon it. After the division of the constricting bands in this situation, by means of a probe-pointed knife carried underneath them, or by dissecting down upon them, an attempt at taxis may be made by compressing the tumour in the usual way, at the same time that its neck is steadied by the fingers of the left hand. If the contents can be reduced, the incision in the superficial structures is brought together and dressed as already described (p. 821). If, after the Surgeon has fairly divided all the structures outside the sac, he still find that the return of the hernia is prevented by some constriction in its neck, it will be necessary to lay this open and divide the constriction in the usual way.

Reduction in Mass.—The reduction of the hernia in mass consists in the return of the sac and its contents into the abdomen still in a state of strangulation. When it is said that the parts are returned into the abdomen, it must not be understood that they are pushed back into its cavity, but that the external protrusion is caused to disappear by being pushed into the subserous areolar tissue behind and underneath the parietal peritoneum, between it and the abdominal muscles. This remarkable accident, which was first described by the French Surgeons of the last century, received but little notice from practitioners in this country until attention was drawn to it by Luke, by whom its pathology was carefully studied. Birkett, who has also investigated this condition with much care, is of opinion that the sac is not torn from its connections in the scrotum or canal, and pushed back, but that it is ruptured, usually at its posterior part at its neck, and that thus the contents of the sac are forced through this rent into the subperitoneal areolar tissue; whilst the mouth of the sac, still constricting the hernia, and thus keeping it in a state of strangulation, is pushed back from the internal ring. It appears to me that both explanations are correct, and that we must admit two forms of reduction in mass; the sac being pushed back intact in a state of strangulation, in one form, as described by Luke; whilst in the other, as observed by Birkett, the sac is ruptured, and the hernia, strangulated by the displaced mouth of the sac, is forced out through the rent.

Causes.—The reduction in mass has been far more frequently observed in cases of inguinal than in those of any of the other varieties of hernia. It has only very rarely been met with in femoral herniæ, and, so far as I know, not in any other form of the disease. The comparative frequency of its occurrence in inguinal herniæ is doubtless due to their large size, and loose areolar connections. The accident has more often occurred from the patient's own efforts at reducing a strangulated hernia, than from those of the Surgeon. It is a remarkable fact that, in most of the instances in which it has occurred, only a very slight degree of force appears to have been employed; and the accident would seem to have resulted from the adhesions between the sac and the neighbouring parts being much weaker than natural, so that a moderate degree of force caused the whole to slip through the canal. It may, however, occur from the Surgeon's efforts, if these be too forcible or long-continued.

Symptoms.—The symptoms indicative of this accident are constitutional and local. The constitutional symptoms consist in a continuance of those that are indicative of the existence of strangulation, notwithstanding the disappearance of the tumour. The vomiting and constipation persist, the patient speedily becomes much depressed, is seized with hiccup and prostration: signs of gangrene then show themselves within the sac; and death ensues. An examination of the parts will usually enable the Surgeon to recognize the nature of the accident; he will ascertain that a tumour had previously existed, and will learn from a description of its general characters, and the symptoms occasioned by it, that it was in all probability a strangulated rupture. He will then find that there is a total absence of that fulness which is occasioned by the presence of the sac, even after its contents have been reduced; the empty sac always giving rise to a feeling of fulness and roundness in the part. He will, on the contrary, find that the abdominal ring is peculiarly open, much larger than usual, and somewhat rounded. On pushing the finger into the canal, this will be found quite empty; but in some cases, on deep pressure with the finger, especially when the patient stands up or coughs, a rounded tumour may be indistinctly felt behind the ordinary seat of the hernia. In many cases, however, the most careful examination will fail to detect any prominence of this kind.

Treatment.—If, after careful examination of such a case as this, in which the symptoms of strangulation continue, the Surgeon learn by the previous history that a tumour has existed, but that it has suddenly gone up; and further, if he find that the seat of the supposed hernia presents the negative evidence that has just been described, it will then be necessary for him to push his inquiries a step further by an exploratory incision. Such an incision as this may first be used as a simple means of diagnosis, and, as it does not penetrate the peritoneal cavity, there is no danger attending it; and if the hernia be found, it will serve the purpose of the ordinary incision required in the operation, and may be used for the relief of the strangulation. The first incision should be made so as to expose the abdominal ring; if this be found peculiarly round and open, it would increase the probability of the existence of the condition sought for. The inguinal canal must next be laid open, and the parts contained within it carefully examined. If no appearance of a hernial sac be found, but the cord be distinctly and clearly seen, still further presumptive evidence will be afforded of the reduction having been effected in mass; for, if the hernia have been put back in the usual way, the sac will necessarily be left in the canal, and will preserve its usual relations to the cord. This supposition will be strengthened almost to a certainty if it be found that the "condensed cellular capsule immediately investing the sac," as it is termed by Luke—in other words, the condensed and laminated subserous areolar tissue—has been left in the canal. An opening made into this will, as that Surgeon observes, allow the finger to be brought into contact with the hernial tumour itself. Should, however, this condensed areolar tissue not be found, it must not be concluded that no hernia is present, inasmuch as this investment may have been accidentally absent. The finger should then be passsed into the internal ring, which will probably be found open, and should be carried from side to side; the tumour, if present, will be detected lying externally to the peritoneum behind the abdominal wall. When found, it must be brought down into the canal by enlarging the ring; it must then be opened, its contents examined, and the stricture in its neck divided. The intestine that has been so strangled must be dealt with in accordance with the rules already laid down. If the tumour cannot be readily brought down so as to allow of an examination of it and its contents, firm pressure may be made upon the abdomen, so as to cause it to protrude. If it still do not come down, it must be opened, and the stricture cautiously divided within the abdomen with a sheathed bistoury.

Treatment of Strangulated Hernia by Aspiration.—Dieulafoy, in 1873, suggested that the reduction of a strangulated hernia might be effected by removing the fluid and gaseous contents of the included portion of the gut by means of the aspirator, through a needle not exceeding $\frac{1}{25}$th in. in diameter, and immediately employing taxis. He recorded 27 cases, in 20 of which the treatment was successful; in the remaining 7 it was harmless. Others, however, have not succeeded in obtaining such results, and Deprés sums up the experience of the Parisian surgeons by saying that one of two things happens; if a small needle be used it becomes choked and withdraws nothing, if a large needle be inserted fæcal extravasation frequently occurs from the puncture. In very large passively strangulated herniæ, tensely distended with gas, the introduction of a fine needle might possibly aid in reduction, and experience has shown that if it be below $\frac{1}{25}$th inch in diameter the risk of fæcal extravasation is scarcely appreciable. In one case in University College Hospital in which aspiration was tried, and the patient died a few minutes afterwards from other causes, neither gas nor fluid could be squeezed from the punctures at the *post-mortem* examination. In ordinary cases aspiration should never be practised in preference to the ordinary operation for hernia.

CHAPTER LXII.

SPECIAL HERNIÆ.

INGUINAL HERNIA.

By **Inguinal Hernia** is meant that protrusion which occupies the whole or a portion of the inguinal canal, and when fully formed, passes out of the external abdominal ring into the scrotum. Many varieties of this hernia are recognized by Surgeons. Thus it is said to be *Incomplete*, or a *Bubonocele*, so long as it is contained within the canal; *Complete*, when it passes out of the external ring; *Scrotal*, when it distends the scrotum; *Oblique*, when it occupies the whole course of the canal; *Direct*, when it passes forwards through a limited extent of it; *Congenital*, when it descends through an unobliterated processus vaginalis and lies in the sac of the tunica vaginalis; and *Encysted*, or *Infantile*, when it lies behind this. Inguinal herniæ constitute the commonest species of rupture, and would be much more frequent than they are, were it not for the obliquity of the canal, and the manner in which its sides are applied to one another, and closely overlap the spermatic cord. They occur with most readiness in those cases in which the canal is short and the apertures wide. Although these herniæ are commonly incomplete in their early stages, it is seldom that they come under observation of the Surgeon until the protrusion has passed beyond the external abdominal ring.

Oblique Inguinal Hernia, often called **External**, on account of its relation to the epigastric artery, passes through the whole length of the canal, from one ring to the other.

Coverings of Oblique Hernia.—As it passes along the canal, it necessarily receives the same investments as the spermatic cord; although these are often greatly modified by being elongated, hypertrophied, and otherwise altered in appearance. If we regard the inguinal canal as consisting of a series of protrusions of the different layers of the abdominal parietes, the outermost being the skin, and the innermost the fascia transversalis with the peritoneum applied to this, it is easy to understand how the hernia in its descent has these prolongations drawn over it, thus becoming successively invested with the same coverings as the spermatic cord. Thus it first pushes before it that portion of the peritoneum which lies in the fossa just external to the epigastric vessels; it next receives an investment from the subperitoneal fat, which, uniting with the fascia transversalis, constitutes the *fascia propria* of the sac; as it passes under the internal oblique, it receives some of the fibres of this muscle, in the shape of the cremasteric fascia; and, lastly, when it reaches the external abdominal ring, which it greatly distends and renders round and open, it becomes covered by the intercolumnar fascia, receiving also a partial investment around its neck from some of the expanded and thickened fibrous bands that lie near the ring, and which are always most marked upon its outer side.

Relations of Oblique Hernia.—The relations of the spermatic cord and testis, and of the epigastric artery, to an inguinal hernia, are of great importance. The *spermatic cord* will almost invariably be found to be situated behind or rather underneath the oblique inguinal hernia; and the *testis* will be found to lie at its lower and back part, where it may always be distinctly felt. In rare cases the elements of the spermatic cord become separated, the vas deferens lying on one side, and the spermatic vessels on the other. In other still rarer cases, a specimen of which is in the University College Museum, the hernia lies behind the cord and has the testis in front. In other cases, again, it may happen that the elements of the cord are all separately spread out on the forepart of the hernial tumour. The *epigastric artery* has the same relations to the oblique inguinal hernia that it has to the spermatic cord, lying to the inner side of and behind its neck. The pressure of large and old inguinal herniæ has, however, a tendency to modify somewhat the relations of this vessel. By distending the rings, and dragging the posterior wall downwards and inwards, they shorten the canal, and cause a great deflection of the artery from its natural course, which is changed from an oblique direction to one curved downwards and inwards, towards the outer edge of the rectus muscle.

Direct Inguinal Hernia.—This does not pass out like the oblique through the internal abdominal ring, but pushes forwards through a triangular space, which is bounded by the epigastric artery on the outer side, the edge of the rectus on the inner, and the crural arch at its base; through this the hernial tumour protrudes, pushing before it or rupturing the posterior wall of the inguinal canal.

Coverings of Direct Hernia.—These vary according to the length of the canal that the hernia traverses, and the portion of the posterior wall through which it protrudes. In fact, there are at least two distinct forms of direct inguinal hernia, which differ according as they are situated internal or external to the obliterated hypogastric artery. One, the most common variety, is situated internal to the cord-like remains of this vessel, between it and the outer edge of the rectus. The other, which is of less frequent occurrence, is situated outside this vessel, between it and the epigastric artery.

In the form of direct inguinal hernia which lies *internal to the hypogastric artery*, the protrusion takes place through that part of the posterior wall of the inguinal canal which is situated almost behind and opposite to the external ring. In this situation, the investments successively received by the hernia are, first, the peritoneum, the subperitoneal fat, and the fascia transversalis; it then comes into contact with the conjoined tendons of the internal oblique and transversalis muscles, which it may either rupture or push before it, thinned out and expanded. Most frequently these are ruptured, constituting a partial investment to the protrusion, which is most evident on the innermost part of the sac, that which is nearest the mesial line. As the hernia passes through the external ring, it receives from it the intercolumnar fascia, and lastly is invested by the common fascia and integuments.

In the rare form of direct inguinal hernia which lies *external to the hypogastric artery*, the protrusion may pass under the lower edge of the internal oblique muscle, and then receives a partial investment of cremasteric fascia, especially on its iliac side, as it comes into relation with the internal oblique. This form of direct inguinal hernia, therefore, receives very nearly the same coverings that the oblique does, though its investment by the cremaster is not so perfect. It does not come into relation with the conjoined tendons.

Relations of Direct Hernia—In the direct inguinal hernia, the *spermatic cord* lies to the outer side of the sac; and its elements are never separated from one another, as occasionally happens in the oblique. The *epigastric artery* also is on the outer side, but usually arches very distinctly over the neck of the sac, sometimes indeed completely encircling the upper as well as the outer margin (Fig. 811).

Incomplete or Interstitial Hernia, or **Bubonocele,** is usually of the oblique kind; but Lawrence has observed that it may be of the direct variety. It often escapes notice, but may not unfrequently be observed on the opposite side to an ordinary inguinal hernia.

Double Inguinal Herniæ, on opposite sides, are of very common occurrence, and they may be of the same, or assume different forms. In some instances, the two forms may be observed on the same side (Fig. 812).

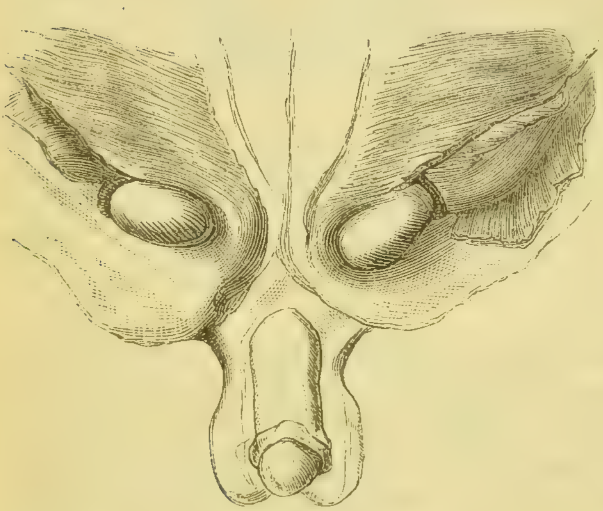


Fig. 811.—Double Direct Inguinal Hernia: Neck of Sac crossed by Epigastric Artery.

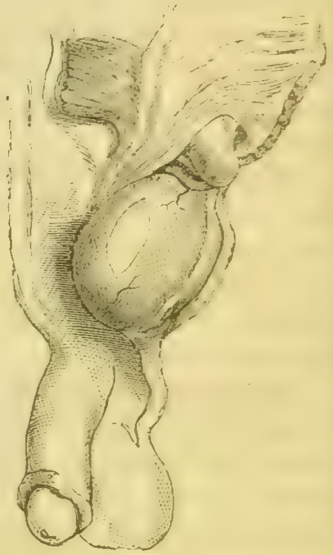


Fig. 812.—Double Inguinal Hernia on the same side: Oblique above, Direct below; separated by Epigastric Vessels.

In females, inguinal herniæ are much less frequent than in males. They may occur at all ages, but seldom come under the notice of the Surgeon except at advanced periods of life. They have the same relations as in the male, except that the round ligament is substituted for the spermatic cord, and they descend into the labium instead of into the scrotum.

Signs of Inguinal Hernia.—The signs of inguinal hernia vary somewhat according to its character, whether incomplete, complete or scrotal, oblique or direct. In the *incomplete hernia*, a degree of fulness will be perceived in the canal when the patient stands or coughs; and, on pressing the finger on the internal ring, or passing it up through the external ring, and directing the patient to cough, a distinct impulse, together with a tumour, may be felt. In the ordinary *oblique inguinal hernia*, a tumour of an oblong or oval shape, oblique in its direction, taking the course of the canal downwards and forwards, will be felt protruding through the external abdominal ring, and presenting all the usual signs of a hernia. So long as it is confined to the neighbourhood of the pubes, it is of moderate size ; but when once it enters the scrotum, where it meets with less resistance, it may gradually enlarge until it attains an enormous bulk. The testicle, however, may always be felt with tolerable distinctness at its posterior inferior part. In women this form of hernia descends into the labium, but never attains the same magnitude as in men. When of large size, these ruptures usually contain both intestine and omentum, most frequently a portion of the ileum, though the various other viscera, such as the cæcum, bladder, &c., have been found in them. In the *direct inguinal hernia*, the symptoms closely resemble those of the oblique, except that the tumour is more rounded, and usually not so large ; the neck is wider, and situated near the root of the penis, with the cord on its outer side. The oblique or external inguinal hernia is most common in young males, whilst the internal or direct form is almost confined to elderly men. This appears to be owing to the imperfect closure of the fascicular process of the peritoneum being the common cause of the first, and absorption of fat of the second form.

The different forms of inguinal hernia are not unfrequently complicated with various other affections ; either with different kinds of rupture, or with diseases of the cord or testis, such as hydrocele of the cord or of the tunica vaginalis, or varicocele. These complications make the diagnosis more obscure, but with care and practice it may generally easily be made out.

Diagnosis.—The diagnosis of inguinal hernia is usually readily effected, the characters and position of the tumour enabling the Surgeon to determine its true nature. In most cases it is useless to endeavour to ascertain whether the hernia is oblique or direct ; all old oblique herniæ having a tendency to drag the inner ring downwards and inwards, so as to bring it nearly opposite to the outer one, shortening or destroying the obliquity of the canal. Hence the direction of the neck and of the axis of the tumour in these cases so nearly resembles what is met with in the direct form of hernia, that the Surgeon should not be guided in an operation, more particularly in the division of the stricture, by any imaginary diagnosis. *Femoral hernia* may occasionally be confounded with inguinal ; the distinguishing points between the two will be considered in the section on femoral hernia.

The diagnosis of inguinal hernia from other diseases in this vicinity has to be considered under the two conditions in which the rupture is found,—1, *in the canal*, and 2, *in the scrotum*.

1. Whilst still lying *in the canal*, inguinal hernia requires to be diagnosed from the following conditions. *a. Abscess*, descending from the interior of the abdomen or pelvis through the canal, and passing out through the abdominal ring. The diagnosis may here be effected by recognizing the soft fluctuating feel of the abscess, which, though reducible on pressure, and descending on coughing with a distinct impulse, does not present the more solid characters and the gurgling sensation of a hernia. *b. Encysted* or *Diffused Hydrocele of the Cord.* In the *encysted hydrocele* there is a smooth oval swelling situated on the cord, which can be apparently reduced, being pushed up into the canal, and descends again on coughing or straining ; but it may be distinguished from hernia by being always of the same size, by not being reducible into the cavity of the abdomen, by the absence of all gurgle, and by its very defined outline. If the testicle be drawn downwards the encysted hydrocele becomes fixed and

is no longer reducible even into the canal. In the *diffused hydrocele* of the cord, the absence of distinct impulse on coughing, and the impossibility of returning the swelling completely within the abdominal cavity, will prevent the diseases from being confounded with each other. *c. Hæmatocele of the Cord.* Here the soft and fluctuating nature of the swelling, the ecchymosis, the impossibility of complete reduction, and the absence of gurgling, will indicate its true nature. *d. Fatty or other Tumours* occasionally form on the cord; but the circumscribed character and limited size of these swellings, the absence of impulse on coughing, and of reducibility into the cavity of the abdomen, and their becoming fixed when the testicle is drawn down so as to put the cord on the stretch, will prove that they are not herniæ. *e. Lodgment of the Testis in the Inguinal Canal* will give rise to a tumour, which closely resembles incomplete inguinal hernia: and if it should happen to become inflamed in this situation, the difficulty of the diagnosis from strangulated hernia may be very considerable. In the ordinary undescended testis, the absence of that organ in the scrotum on the affected side, the peculiar sickening pain occasioned by the pressure of the tumour, the absence of gurgling, and of all possibility of reduction, will enable the diagnosis to be effected. *f. Inflamed Undescended Testis.* From this it is not always at once easy to effect the diagnosis of incomplete inguinal hernia in a state of strangulation, with which indeed it may be complicated. This point in diagnosis will be more fully treated of in speaking of congenital hernia. In the meanwhile, it may be stated that the absence of *persistent* and *continuous* vomiting and constipation, the feel of the tumour, hard below, elastic above, and the peculiar testicular pain when it is compressed, will enable the Surgeon to recognize its true nature.

2. When the hernia has descended *into the scrotum*, it may be confounded with: *a. Hydrocele of the Tunica Vaginalis.* In this disease there is an oval or pyriform tumour, usually translucent, dull on percussion, unchangeable in size or shape by pressure, and having the cord clear and distinct above it, with an absence of impulse on coughing, or of gurgling in attempts at reduction. The patient will usually have noticed in hydrocele that the swelling first appeared at the bottom of the scrotum, while in hernia it descended from above. In cases of congenital hydrocele in children, in which there is still an opening communicating with the peritoneal cavity, the tumour may be diminished in size by steady pressure, but gradually returns, fluctuates, and is translucent. In these cases its translucency, and the gradual manner in which the sac is emptied and is refilled, very different from the sudden slipping up and protrusion of a hernia, enable the Surgeon to establish the diagnosis. In infants, however, it must be remembered that a hernia is often translucent, as it seldom contains omentum, and the contents of the gut may be chiefly gas. It not unfrequently happens that *hernia is complicated with hydrocele of the tunica vaginalis.* In these cases the two separate tumours can usually be distinguished, there being some degree of constriction, or of consolidation, between them. The hydrocele will present its ordinary characters of translucency, irreducibility, and circumscribed outline, and is placed chiefly below the hernia, which lies towards the upper and anterior part of the scrotum and may be distinguished by its reducibility and impulse on coughing. It sometimes happens, as in a case which once fell under my observation, that a *hydrocele of the cord is associated with one of the*

tunica vaginalis and a hernia; in such circumstances, the diagnosis requires a little care, but may be effected readily enough by separately determining the characters of the different swellings. *b. Varicocele.* Here the diagnosis may be effected in the way pointed out by Sir A. Cooper. The patient should be placed in the recumbent position, and the swelling reduced; the Surgeon then presses upon the external ring with his fingers, taking care to cover the whole of it, and desires the patient to stand up. If it be a hernia, the tumour cannot descend; but if it be a varicocele, it will reappear *whilst the pressure is being kept up,* the blood being conveyed into it through the spermatic arteries. *c. Tumours of the Testis.* These may be distinguished from hernia by their solid feel, rounded shape, by the absence of all impulse on coughing, and, especially, by the cord being felt free and clear above them, and the inguinal canal unoccupied. *d. Hæmatocele of the Tunica Vaginalis.* Here the cause of the swelling, its oval shape, opacity, solid feel, the absence of impulse on coughing, and the defined characters of the cord, will enable the Surgeon to make the diagnosis.

Treatment.—When inguinal hernia is reducible, the rupture must be kept up by a well-made truss, the pad of which, of an oval shape, should press not only upon the external ring, but upon the whole length of the canal. In this way a reducible hernia may occasionally be cured, especially in young subjects. When the hernia is of large size and irreducible and the patient beyond middle life, as a rule no operation for radical cure should be undertaken. In such cases the rupture must be supported in a bag-truss. Small irreducible inguinal herniæ, chiefly or entirely omental in young subjects, are fit cases for the radical cure by the open method.

Radical Cure of Inguinal Hernia.—There are three chief methods by which the radical cure of inguinal hernia has been accomplished: 1. Wutzer's operation; 2. Wood's subcutaneous method; and 3. The open operation.

Wutzer's Operation.—In the operation invented by C. W. Wutzer, of Bonn, the objects aimed at were to cause agglutination of the neck of the sac by exciting adhesive inflammation in it, and to close the inguinal canal by the invagination of a portion of the scrotum. He accomplished these objects by means of the instrument represented in Fig. 813. The operation is thus performed. The patient lying on his back and the hernia being reduced, the Surgeon pushes his index-finger up the inguinal canal as high as the internal ring, carrying before it a cone of the scrotal tissues; a boxwood cylinder about four inches long, perforated by a curved steel tube opening on the surface about three-quarters of an inch from the round end, is then pushed up as the finger is withdrawn so as to occupy its place in the inguinal canal, the opening on the surface being directed forwards. Along the tube in the

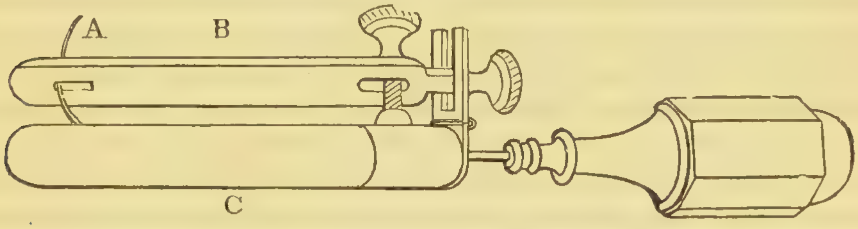


Fig. 813.—Wutzer's Apparatus for Radical Cure of Hernia.

cylinder a flexible steel needle, gilt (A), fixed in a movable handle, is then pushed, so as to traverse the invaginated scrotum, the hernial sac, and the anterior abdominal wall, through which its point is caused to protrude. A concave boxwood case (B) is then passed over the projecting point of the needle, and fixed by the other end by a screw apparatus to the cylinder (C), so as to compress the enclosed tissues. The apparatus so fixed is left *in situ* for six or eight days; when, some discharge being established, it is withdrawn, and the invaginated scrotal plug supported by lint introduced up its interior, and by a spica bandage tightly applied. The patient is kept quiet for a fortnight longer, when he is allowed to move about, wearing a light truss for three or four months.

At the time of its invention this operation was probably safer and more successful than any method then in use. It was accompanied by very little danger of peritonitis, and although failure was frequent, successes were not uncommon. I have very often performed it, and have never met with any complication beyond occasional abrasion of the skin, and I kept under observation several cases in which the cure was permanent from two to nine years after the operation. Wutzer's operation is, however, now practically abandoned in favour of the methods to be next described.

Wood's Subcutaneous Operation.—The principle of this operation consists in the invagination of the sac of the hernia and the approximation of the tendinous structures forming the boundary of the hernial canal by the application of a subcutaneous suture through a small opening in the skin. In his earliest operations Wood used a hempen ligature, but in order to prevent the suppuration that followed this method, he subsequently employed stout copper wire silvered. Lately he has used a stout piece of kangaroo, deer or ox tendon antisepticised in carbolized oil and softened by being soaked in 1 in 40 carbolic lotion immediately before use. The latest modification of the operation as described by Wood in his Hunterian lectures in 1885 is thus performed. The instruments required are, a tenotomy knife, a semi-circular needle, mounted on a stout handle, flattened at the eye, with a sharp point and blunt shoulders. formed so as to slip along the front of the curved forefinger, with about a foot of tendon or wire as thick as stout twine. The patient is laid on his back with his shoulders raised. The scrotum and pubes are shaved and cleaned with carbolic lotion, and all other ordinary antiseptic precautions are taken. The hernia being reduced, a small incision, about three-quarters of an inch long, is made with the tenotomy knife over the cord, and parallel to it just below the pubic crest. This is carried down to the sac, any bleeding vessel being secured as it is cut. The finger is then passed into the canal as far as the internal ring, carrying the sac invaginated before it. At the inner side the conjoined tendon can be felt and the finger passed behind it. The needle is then carried along the finger until its point can be felt behind the conjoined tendon, through which it is pushed so as to project beneath the skin. The integuments are then drawn well over to the inner side and the needle pushed through the skin. The needle is then threaded with the tendon suture, or if wire be used a bend at the end of it is hooked on. The needle is then withdrawn at the scrotal wound and the suture detached, leaving about six inches projecting from the puncture in the abdominal wall. The finger is then passed behind Poupart's ligament, and the spermatic cord felt for and pushed aside. The point of the finger is then carried close to the ligament along the groove of the outer pillar of the external ring to a point opposite the internal ring, the needle is then passed through the aponeurosis of the external oblique and by drawing the skin well outwards is made to appear at the puncture already made. The end of the suture which is projecting from the puncture is then attached to the needle, which is drawn out at the scrotal wound. There is thus a loop left projecting at the puncture on the abdominal wall, and two free ends from the scrotal wound. The needle is then carried from the scrotal wound across behind the sac between it and the cord, the latter being isolated and drawn backwards with the finger and thumb of the left hand while the needle is being passed, as in the operation for varicocele. The end of the suture, which passes through the conjoined tendon, is then attached to the eye of the needle and drawn through between the cord and the sac. If the hernia be large and the ring wide, the needle is now to be passed again from the scrotal wound "through the end of Poupart's ligament, just above the pubic spine, and then carried through the inner pillar of the ring and the triangular fascia, close to the os pubis, at the edge of the rectus muscle." The outer edge of the suture, that passing through the outer pillar of the ring, is then connected with the needle and drawn across "so as to lace up the canal like a boot."

If a tendon suture is used the ends are now drawn firmly downwards at the scrotal wound, by which the loop projecting at the puncture in the abdominal wall will be drawn in beneath the skin. The free ends are then secured firmly by a reef-knot, cut short and buried in the wound. A short drainage-tube is then inserted reaching to the external ring, and an antiseptic dressing applied. If all goes well the wound heals by first intention, and the tendon suture is gradually absorbed.

If wire is used a loop is left at the puncture in the abdominal wall; the lower ends are twisted down into the scrotal aperture, the upper loop drawn upon so as to tighten the wire, and held firm by two or three twists down into the puncture. The bight of the upper loop is then bent downwards to meet the ends bent upwards; these are curved into the form of a hook to fasten on the loop. A firm pad of lint is placed on the skin under the arch thus formed, and a broad spica bandage secures the whole. No drainage is required. The wire is removed in a week or ten days. The lower end is first untwisted and the ends stretched to take out the spiral twist, and then cut short. Traction on the loop will then usually bring the wire out in one piece, but if there is any difficulty, the loop must be untwisted and the two pieces removed separately. In 1885 Wood had performed this operation 339 times, with 7 deaths, or about 2 per cent., one of which occurred from pyæmia after the use of the hemp ligature. Taking the wire operations alone, there were 273 with 4 deaths, one from tetanus, one from delirium tremens, and two from broncho-pneumonia. If the operation performed by the later improved methods alone are taken 82 per cent. of the cases were cured of the hernia. The operation should only be undertaken in properly selected cases. Recent herniæ in young healthy subjects are the most favourable.

An ingenious operation, much the same in principle as Wood's, has been devised by W. Dunnett Spanton. After invaginating a portion of the subcutaneous tissue of the scrotum and the sac as in Wood's method, instead of passing wires he inserts an instrument like a cork-screw, the point of which is introduced through the skin at the upper limits of the inguinal canal. By rotating the handle the point guided by the finger in the canal, which at the same time protects the cord, is made to penetrate the same parts as are pierced by the needle in Wood's operation as well as the invaginated subcutaneous tissue, and it is finally made to emerge at the incision in the scrotum. In this way the parts are thoroughly brought together and held in position. The instrument is left in for about a week, till some inflammatory swelling is perceptible around it. The instrument must be suited to the size of the patient. Up to 1882, Spanton had operated on 51 cases without an accident, and with most satisfactory results. It is especially adapted to young subjects with recent herniæ, especially when of the congenital variety.

The Open Operation.—Since the introduction of the antiseptic method of treating wounds the old operation of ligature of the neck of the sac and cutting it away has been revived and practised with great success. In 1871 Sir Joseph Lister reported two cases in which he cut down upon a hernial sac and closed the abdominal opening with catgut sutures. Experience, however, showed that suture of the ring alone was not enough to effect a cure. Since then Annandale, Banks, Czerny, Ball, Macewen, and many others have devised various proceedings having the common object of obliterating the neck of the sac and narrowing the dilated ring. The operation as performed by Banks may be taken as a type, and the various modifications of other operators may be subsequently noticed. The operation is thus performed. The whole area having been cleaned with soap and water followed by turpentine to remove grease, and spirit to remove the turpentine, is covered with a towel soaked in carbolic lotion (1 in 20) for an hour before the operation. A free incision is then made, reaching from about one inch above the external abdominal ring to near the bottom of the sac. The dissection is then carefully carried down to the sac, all bleeding vessels being secured as they are cut, and great care being taken that the sac itself is exposed in the whole length of the wound, and that one of the coverings be not mistaken for it. The sac is then very carefully dissected out with as little damage to the scrotal tisues as possible. It will usually be found to be slightly adherent to the tunica vaginalis, requiring some careful dissection to separate it. The cord must be early sought for and separated from the sac. The vas deferens can easily be recognized by its cord-like feel, and must be kept in view during the whole operation. The sac being completely separated is emptied of its contents if they are reducible, and opened to make sure that it is really empty. If omentum is present in the sac and is irreducible, either from its size or from the presence of adhesions, it must be cut away in the manner already described (p. 828), and the pedicle reduced into the abdominal cavity. The sac is then drawn well down and ligatured as high up as possible, so that the inner aspect of the peritoneum may be smooth and not present a pouch, which might favour the formation of a fresh hernia. The ligature may be of chromic catgut or of fine carbolised silk. The sac below the ligature is then cut away. The next step in the operation is to close the pillars of the ring by sutures. These must be introduced by means of a curved needle guided by the finger passed into the canal. The sutures should get a firm hold on each side of the ring, and three or four may be required according to the size of the aperture. While passing the sutures care must be taken not to injure the cord, which must be kept out of the way with the finger, and the situation of the epigastric artery should be felt for lest it be punctured by the needle. The sutures may be of carbolised silk, kangaroo tendon, or catgut. Banks uses silver wire, which he ties in a single knot and cuts very close, so as to leave no projecting ends, and allows to heal into the wound.

In congenital hernia the sac must be cut across, leaving the lower part to form a tunica vaginalis. This may be closed by catgut sutures. The upper part is then separated from the cord and treated as above described.

After the operation an absorbent antiseptic dressing should be applied and covered with a piece of jaconette or other thin waterproof material, with a hole through which the penis should be drawn, so that the dressing shall not be soiled during micturition.

The chief modifications of the operation above described are first in the treatment of the sac, and secondly in the closure of the ring. In the first place many Surgeons content themselves with ligaturing the neck of the sac and dividing it below the ligature, leaving the fundus undisturbed in the scrotum. This certainly greatly simplifies the operation, and the part of the sac left behind seems to give no trouble in the after-treatment. A. E. Barker after ligaturing the neck of the sac with fine silk and dividing it below passes the two ends of the ligature through the borders of the ring as high up as possible, and thus fixes the stump of the sac, and at the same time the ligature serves as the highest stitch in closing the ring. Macewen after dissecting out the sac and emptying it, inserts the index finger outside the sac till it reaches the internal ring and separates the peritoneum from the abdominal wall for about half an inch. He then inserts a long catgut suture into the distal extremity of the sac ; the free end of this is then passed in a proximal direction several times through the sac, so that when pulled upon the sac is folded upon itself like a curtain ; it is then passed by means of a needle through the inguinal canal and made to penetrate the abdominal muscles about an inch above the level of the internal ring. By pulling on this thread the sac is folded upon itself and dragged into the inguinal canal, the part that was the fundus being highest up. It is finally fixed in this position by passing the end of the thread several times through the superficial layers of the muscles. The pad thus formed helps to obliterate the inguinal canal. The ring is afterwards closed with sutures. Ball, of Dublin, has recommended twisting the stump of the sac four or five times with torsion-forceps as a means of more certainly occluding it.

In closing the ring silk, catgut and wire have been used. Perhaps silk is the best, as it is not too early absorbed, and can be rendered aseptic with great ease and certainty. Most Surgeons simply pass the sutures through each side of the ring without paying any special attention to the structures pierced by the needle, care being merely taken to avoid injury to the cord either by puncture or by strangulation from too tight closure of the ring. Macewen first passes a thread through the conjoined tendon, leaving two free ends superficially and a loop behind. The free ends are then passed through the aponeurosis of the external oblique in the outer side of the ring. By tying these the canal is very completely closed.

The **Results** of the open operation have generally been very satisfactory. Thus Macewen records 49 cases of radical cure, and Barker 41 without a death. Banks's statistics also show that the operation, when undertaken in uncomplicated cases, is very successful. It must not be assumed, however, that it is free from danger, and should be indiscriminately recommended in all cases.

Banks lays down the rule, which is undoubtedly a wise one, that it should never be undertaken when the hernia can be kept up without serious discomfort by a truss. In strangulated hernia, if the gut is sound and the patient not too much exhausted, the operation should always be completed by a radical cure.

Of the methods of operating above described, the open method is probably the easiest and the most certain. Wutzer's operation is uncertain, and is now practically abandoned. Wood's operation, although very successful in the hands of the inventor, has never been very generally adopted; and the same may be said of Spanton's. The open method is easy of performance, and with proper attention to antiseptic treatment, is sufficiently free from danger to be preferable to all others.

Operation for Strangulated Inguinal Hernia.—When the hernia is strangulated, if the taxis properly employed in the direction of the canal have failed, the operation must be performed in the following way. The pubes having been shaved, the patient should be brought to the edge of the bed; and the Surgeon, having the skin covering the external ring well pinched up, divides the fold in the usual way, by an incision two inches in length, commencing about half an inch above the external abdominal ring. Should any spouting vessel, as the external pudic, be divided in this incision, it must be secured at once. The Surgeon then proceeds with the section through the subcutaneous structures; he will, in many cases, find the superficial fascia considerably thickened, particularly if the patient have long worn a truss. He divides this structure in the line of the external incision, and then exposes the intercolumnar fascia, which will also generally be found thickened, and incorporated with the superficial fascia. In many cases, the intercolumnar fibres will be found condensed into a thick and broad fillet, which limits the further extension of the ring, and produces an evident constriction upon the neck of a large inguinal hernia. An opening should be carefully made into the fascia, a grooved director passed under the edge of the ring, and this slit up. In some cases, though but very rarely, it will now be found that the hernia may be reduced, its strangulation depending on the constriction of the margins of this aperture; most, commonly, however, the stricture is situated deeper than this. The cremasteric fascia, which is generally considerably thickened, is now exposed, when its fibres will be found to form a kind of reticulated mesh over the hernial tumour. This structure must be carefully divided upon a director, when the transversalis fascia and subserous areolar tissue, or *fascia propria*, will be laid bare. This structure is usually thickened and vascular, and not unfrequently the stricture appears to be situated in it, or in a kind of condensed ring formed by the incorporation of it with the meshes of the cremaster. If it be found, after the division of these fasciæ, that the hernia can be reduced, it would be unnecessary to lay open the sac. If, however, as will happen in the majority of instances in inguinal hernia, it be found that the stricture is in the neck of the sac itself, occasioned by a condensation, constriction, and puckering of it, the sac must be carefully opened at its anterior part, the finger introduced, and the stricture divided from within, by pressing the finger-nail under it, and cautiously sliding the hernia-knife along this. It is an established rule in surgery, that this division should be effected in a direction *immediately upwards*, so that it may lie parallel with the epigastric vessels, whether it be situated upon the inner or outer side of these. It is true that, if the Surgeon could be sure that he had to do with an oblique inguinal hernia, he might safely divide the stricture outwards ; or, if he were certain that the protrusion was of the direct kind, he might make the section inwards ; but, as it commonly happens that he cannot determine with absolute certainty upon which variety of hernia he is operating, he adopts the safer plan recommended by Sir A. Cooper and Sir W. Lawrence, of cutting upwards from the middle of the ring parallel to the epigastric vessels. After the hernia has been reduced the ring may be closed in proper cases, as already described.

The **Seat of Stricture** in inguinal hernia will thus be seen to differ in different cases ; and in some instances it exists in two situations. I think it most commonly occurs in the neck of the sac, owing to contraction and elongation of it, with condensation of the subserous areolar tissue lying immediately upon it. In other cases, though much more rarely, it seems to be formed by a thickening of the transversalis fascia in the inner ring, but altogether outside the sac. Occasionally it is met with in some part of the canal, at the lower edge of the internal oblique, but much more frequently at the external abdominal ring. In many cases there is very tight constriction in this situation, as well as in the deeper portions of the canal, or at the inner ring ; hence, after the division of any stricture at the external abdominal ring, the deeper portions of the canal should always be carefully examined before any attempt is made to put the hernia back.

The **Operation for an Incomplete Inguinal Hernia** requires to be conducted in the same way as that which has just been described, except that the incision need not be quite so long, and should not extend beyond the external ring. After this has been laid open, and the tendon of the external oblique slit up, a flat director must be passed under the lower edge of the internal oblique, which must be carefully divided ; should the stricture not be relieved in this way, and the sac require to be laid open, the deep section must be made in the same way and in the same direction as has already been described.

In **Inguinal Herniæ, containing either the Cæcum, the Sigmoid Flexure of the Colon, or the Urinary Bladder**, the protruded viscera are only partially covered by peritoneum ; hence, in operating upon such herniæ, when strangulated, care must be taken that the contents be not wounded, which is apt to occur if the Surgeon divide the parts without due caution, not suspecting himself to have reached the neighbourhood of the viscus, but believing that he has met with a sac which does not exist. As the protruded parts are generally adherent in these cases, the Surgeon must content himself with leaving them unreduced after the division of the stricture ; in such circumstances it has happened that the protrusion has ultimately been drawn back into the abdomen by some natural action of the parts.

Operations for strangulated inguinal hernia are required during a greater range of ages than those for any other kind of protrusion. I have operated successfully for congenital hernia in infants less than six weeks old, and for ordinary oblique inguinal hernia at seven weeks and at four months of age ; and the operation has been done on centenarians. When small and recent, the protrusion usually consists of intestine only ; when large, it commonly contains omentum as well. The treatment of these contents, and the after-management of the case, must be conducted in accordance with the rules laid down at p. 821 *et seq.*, Vol. II.

Hernia in the Tunica Vaginalis. Congenital Inguinal Hernia. In the fœtus the testis originally lies below the kidney, and as it descends in the later months of intra-uterine life into the inguinal canal and scrotum, it pulls down a prolongation of the peritoneum resembling a hernial sac known as the processus vaginalis testis. This may be divided into two parts, the *funicular* or that which corresponds to the cord, and the *testicular* or that which covers the body of the testis. The funicular portion normally becomes obliterated, and is finally represented by a delicate thread of fibrous tissue amongst the structures of the spermatic cord, while the unobliterated testicular portion forms the tunica vaginalis testis. It occasionally happens that the funicular portion of the processus vaginalis testis is not obliterated, and thus a communication remains between the general cavity of the peritoneum and the tunica vaginalis. Along this unobliterated processus vaginalis testis, the gut and omentum may descend into the tunica vaginalis, and thus constitute the condition known as congenital inguinal hernia. It therefore differs from ordinary inguinal hernia in the fact that the sac is not a new formation. The hernia is necessarily oblique, following the course of the cord. When the testicle has imperfectly descended into the scrotum, the hernia may remain in the groin, but most commonly it reaches the scrotum. Its occurrence is supposed in some cases to be favoured by an abnormally long mesentery, but this is doubtful.

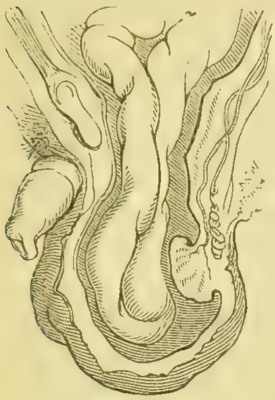


Fig. 814.—Congenital Hernia.

Hernia in the tunica vaginalis, though usually called " congenital," is rarely so in reality ; the tendency is congenital, but the disease is not. It not unfrequently happens, it is true, that these herniæ show themselves early in life, in infants a few weeks or months old ; though even at these ages the funicular prolongation of the peritoneum may be so completely occluded that the hernia which occurs is of an ordinary character. Not unfrequently, however, the hernia does not take place until a considerably later period of life than this, and may suddenly happen in the adult ; thus Velpeau relates instances in which it occurred for the first time between the ages of eighteen and twenty-five. I have operated on a man thirty-five years of age, in whom this kind of hernia occurred for the first time when he was twelve years old ; and some years ago at the Hospital, on a man about fifty, in whom, on the most careful inquiry, it would appear that the protrusion had not shown itself until he was about thirty years of age.

Signs and Diagnosis.—The signs of hernia in the tunica vaginalis closely resemble those of the ordinary oblique ; most commonly, however, if scrotal, the tumour is much rounded, and the neck feels narrow and constricted. The testis, also, cannot be felt distinct and separate from the tumour, but is surrounded by, and, as it were, buried in the substance of the hernia, through which it may sometimes be felt at the lower and back part of the scrotum. In an ordinary inguinal hernia, the tenser the sac the more clearly is the testicle seen and felt outside it. In a congenital hernia, if the sac is tense the testicle cannot be felt at all. On inquiry, also, it will sometimes be found either that the hernia has existed in childhood, or that the testis is still in the canal, or has descended later than usual. A hernia of the tunica vaginalis may be associated with a congenital hydrocele. In these cases, after the fluid has been returned into the peritoneal cavity by directing the patient to lie on his back and raising the scrotum, the portion of protruded gut may be felt and recognized by its gurgle and upward slip when reduced. This hernia may be associated with the testis, either undescended or lying at the external abdominal ring. In the first case, the hernia is, of course, incomplete ; in the second, it is scrotal. When incomplete, the diagnosis may be made by feeling a soft swelling with the ordinary hernial signs above the small and hardened testis.

When symptoms of strangulated hernia occur in a person in whom the *testes have not descended* into the scrotum, very great difficulty may be experienced in effecting an exact diagnosis. In such cases as these, an oblong or rounded tumour, tense and painful, will be found to occupy the inguinal canal, not passing beyond the external ring, with some abdominal tenderness, and possibly nausea and constipation. The question here arises as to the nature of this tumour. Is it simply an inflamed undescended testis ; or is it an undescended testis, inflamed or not, as the case may be, having a knuckle or loop of strangulated intestine lying behind it ?

When the tumour consists simply of an inflamed undescended testis, the pain will be of that peculiar character which is indicative of orchitis, and the constitutional symptoms of strangulation, however simulated for a time, will not be persistently present. The following case is a good illustration of this condition. A man, aged about forty, said to be labouring under strangulated hernia, was sent up from the country for operation. On being called to him, I found the house-surgeon attempting the reduction of the tumour in the hot bath ; but as soon as I felt the swelling, I was convinced, from its hard, solid, and irregular feel, that it was not a hernia. On inquiring into the history of the case, it appeared that the patient had for the previous two days suffered from occasional vomiting, and had been constipated ; that the tumour in the groin had not appeared suddenly, though it had enlarged with great rapidity ; that it was excessively painful ; and that he had always worn a truss for a supposed rupture on that side, until the last few weeks, when, in consequence of the instrument breaking, he had discontinued it. On examining the groin carefully, a tumour about as large as the fist was found in the right inguinal canal ; it was tender to the touch, hard, and irregular at the upper and outer part, but somewhat soft and fluctuating below ; when the finger was passed into the external ring, the outline of the tumour could be very distinctly felt in the canal. There was no impulse in it on coughing, but there was some abdominal tenderness on that side. The right testis was not in the scrotum. I ordered the man to be bled, the tumour to be leeched, and salines administered ; under this treatment the case did well. When a knuckle of strangulated intestine lies behind and above the testis, still retained above the external ring, the symptoms of strangulation will be violent and persistent ; and this, even though the tumour present but little the feel or the ordinary character of a hernia. In fact, in such a case, the Surgeon is guided by the character of the general symptoms, and not by those of the local tumour. In a case of this kind to which I was called, there could be felt behind and above an inflamed and swollen testicle which lay at the external abdominal ring, a small, hard, round tumour in the upper portion of the canal. As symptoms of strangulation were urgent, this was cut down upon, the anterior wall of the canal was incised, and the tunica vaginalis, much distended with fluid, was laid open, when a small knuckle of intestine was found lying at its upper part, very tightly constricted by the inner ring. But in other cases the diagnosis is not so easy; the whole tumour lying in the canal feels smooth, elastic, and uniform, so that no manual examination can enable the Surgeon to say with certainty whether the tumour is an inflamed testis surrounded by fluid in a distended tunica vaginalis, or whether there is a loop of intestine lying above an undescended testis. In such cases as these, however, the Surgeon is guided in the course he should adopt by the symptoms. If these indicate strangulation of intestine he should, without further delay, cut down on the tumour and examine its nature. If it be hernial in part, the internal ring will require division, the intestine must be reduced, and the testis put back in the canal.

The **Treatment of Congenital Hernia** consists in the reduction of the tumour, and the application of a proper truss, the pad of which should compress the whole length of the inguinal canal. In children, a radical cure may be effected in this way; but, in order to accomplish this desirable result, the truss must be worn for several years. The application of a truss with an air-pad will in many instances be found especially useful, as it applies itself with greater exactness than an ordinary incompressible one. In applying the truss, care must be taken not to compress the testis if undescended. In order to avoid this, the lower end of the pad may be cut out so as to be concave, and thus press down the testis while it supports the hernia.

When strangulated, congenital hernia does not commonly admit of reduction, and thus necessarily renders an operation imperative. The procedure is more commonly required for this kind of hernia in adults than in infants. The operation is the same as that for oblique inguinal hernia, but the parts concerned are usually thinner, the tunica vaginalis serving for a sac; hence more caution than usual is required in these cases. The sac commonly contains a large quantity of fluid, clear or dark in colour, according to the severity of the strangulation. The stricture will always be found in the neck of the sac, at which point it is often constricted by a sharp narrow ring; hence it is useless in these cases to endeavour to relieve the strangulation, without laying open the sac and dividing its neck from within. The stricture, in fact, appears to be formed by the imperfect contraction of that portion of the funicular prolongation of the peritoneum, which normally becomes obliterated before birth, and establishes the separation between the two serous sacs of the tunica vaginalis and of the peritoneum. As the congenital hernia is always external to the epigastric vessels, the section of the stricture may be done with perfect safety in a direction upwards and outwards, though, if the Surgeon should have any doubt as to the exact nature of the case, it will be better to divide the stricture directly upwards. The reduction of the contents of the hernia may in the adult be prevented by adhesions in the neck of the sac, or between them and the testis. I have found both the gut and omentum closely incorporated with this organ, and requiring some nice dissection to separate them. In operating upon infants of a very tender age, much caution will necessarily be required, on account of the thinness of the coverings, their tension, and the small size of the apertures. The narrow ring forming the stricture may often in these cases be ruptured by passing a director under it and stretching it, and the use of the knife is thus avoided. The testis, as well as the spermatic cord, the veins of which are excessively turgid, come into view, and will usually be found much congested, and of a black or bluish-black colour.

A species of congenital hernia has been met with in the *female*, especially in children, in which the protrusion takes place into the canal of Nuck, which invests the round ligament. In one instance, I have seen a double inguinal hernia in a girl of five years old. It is of extremely rare occurrence, and requires the same treatment as the corresponding disease in the male.

Encysted Hernia of the Tunica Vaginalis, or Infantile Hernia, as it has been somewhat absurdly termed, occurs in those cases in which the funicular portion of the tunica vaginalis is partly obstructed by a septum, or by being converted into filamentous tissue, but in such a way as to leave a pouch above, which is protruded down behind or into the tunica vaginalis, so that it lies behind this cavity (Fig. 815). There are no characters by which the encysted can be distinguished from the ordinary congenital hernia. If it should become strangulated, it must be borne in mind that during the operation the tunica vaginalis will first be opened; no hernia will be seen here, but the tumour lies behind this sac, and requires to be dissected into through the double serous layer of which it is composed. The stricture will probably be in the neck, and requires to be divided in the usual way.

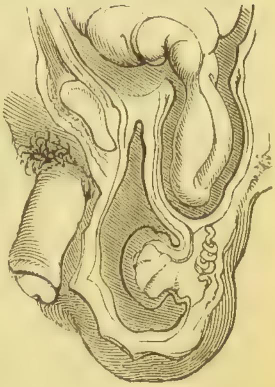


Fig. 815.—Infantile Hernia.

FEMORAL HERNIA.

By **Femoral Hernia** is meant a protrusion that escapes under Poupart's ligament, and enters the sheath of the vessels internally to the femoral vein. This hernia passes down the innermost compartment of the sheath, which is occupied by fat and lymphatics, and usually contains a gland or two. It passes first of all through the crural ring, where it has Gimbernat's ligament to its inner side; the septum which separates the femoral vein from the inner compartment of the sheath of the vessels, to its outer aspect; Poupart's ligament in front; and the bone behind (Fig. 816). After passing through the crural ring, it enters the crural canal, which extends for about half an inch down the thigh in front of the pectineus muscle, and is covered by the iliac

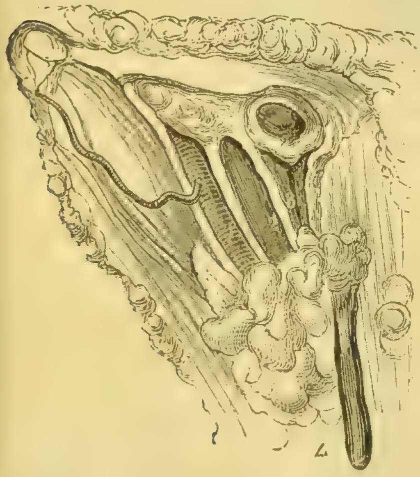


Fig. 816.—1. Femoral Artery; 2. Femoral Vein; 3. Innermost Compartment of the Sheath of the Vessels, into which a small Hernia is protruding; 4. Saphena Vein.

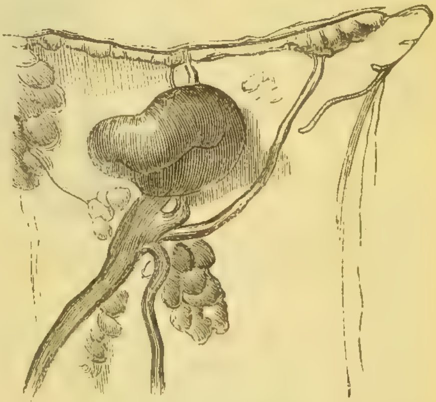


Fig. 817.—Femoral Hernia turning upwards.

prolongation of the fascia lata. As it approaches the lower corner of the saphenous opening where the canal terminates, it passes under the falciform process of the fascia lata, and out upon the thigh through the saphenous aperture ; here it expands, becomes rounded, and has a tendency to turn upwards over Poupart's ligament (Fig. 817), lying in this way upon the iliac region, and sometimes even ascending to some distance upon the anterior abdominal wall. In the descent of the hernia through this course, it first pushes before it the peritoneal sac, and then receives an investment of the subserous areolar tissue—the **septum crurale,** a mass of dense areolar tissue, containing fat and lymphatics, occupying the crural ring. This septum often becomes incorporated with the contiguous portion of the sheath, thus constituting the **fascia propria** of this hernia, which is commonly thickened, laminated, and of an opaque fatty structure, like omentum. As the hernia continues to descend, it comes into relation with the cribriform fascia, which occupies the saphenous opening ; and, lastly, it pushes before it the integumental structures.

As the tumour descends through this course, it necessarily comes into relation with very important parts (Fig. 818). Thus it is separated from the femoral vein solely by the septum of the sheath of the vessels. It has the epigastric artery above and to its outer side ; and the spermatic cord in the male, or the round ligament in the female, almost immediately above it. The obturator artery, when arising in the normal manner from the internal iliac, does not come into relation with the neck of the sac ; but when it takes its origin, as it not unfrequently does, from the external iliac, the epigastric, or the common femoral, it may have important relations to this part of the hernia. Most commonly, in these circumstances, it passes to the iliac or outer side of the neck, but occasionally it winds round its inner or pubic side, coming into close relation with it ; and then, as will immediately be mentioned, it may be in considerable danger during the operation. The combination, however, of this particular

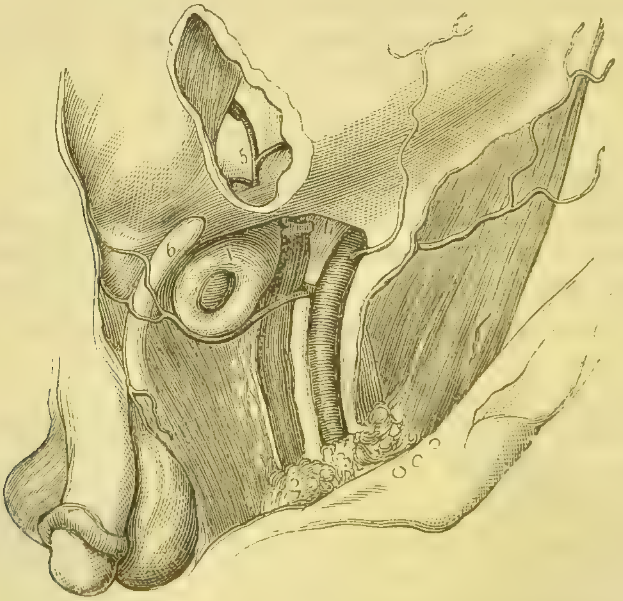


Fig. 818.—1. Femoral Hernia ; 2. Femoral Vein ; 3. Femoral Artery, giving off, 4, Common Trunk of Epigastric and Obturator Arteries, and 5, Epigastric Artery ; 6. Spermatic Cord.

variety of the obturator artery and femoral hernia, is a very uncommon occurrence; because, in the first place, this internal distribution of the artery is rare; and when it does occur, as it usually passes directly over that portion of the crural ring through which the sac would protrude, it necessarily strengthens this, and so diminishes the chance of rupture.

Contents.—The contents of a femoral hernia are usually intestinal, and most commonly consist of a portion of the ileum. Occasionally omentum is contained within the sac, but seldom in large quantity. I have, however, several times had occasion to operate in cases of old femoral hernia, in which it became necessary to remove large portions of adherent omentum; in one, ten and a half ounces, and in another about seven. In each case there was a small knuckle of intestine strangulated behind the omentum. The ovaries, Fallopian tubes, &c., have been met with in this variety of hernia.

Signs.—The signs of femoral hernia are usually well marked. They consist of a tolerably firm and tense tumour, of a rounded shape, situated in the groin, to the inner side of the femoral vessels, and to the outer side of the spine of the pubes, having its neck under Poupart's ligament, though, as it increases in size, its base is turned above that structure; sometimes, though rarely, it passes downwards upon the thigh. Its size varies considerably; most commonly it is not larger than a walnut or a pigeon's egg, and then is deeply seated in the angle between the body of the pubes and the femoral vessels; but occasionally it may attain a considerable bulk, as large as the fist or a French roll. When large, this hernia rises up above Poupart's ligament, and extends outwards parallel to it, so that it assumes an elongated shape; it is then usually somewhat doughy and soft, even when strangulated—very different from the excessively tense feel that it has when small.

In some rare cases the femoral hernia has been found lying external to the vessels, the mouth of the sac being between them and the iliac spine. In these circumstances strangulation cannot well occur, inasmuch as the mouth will be the widest part of the sac; but, as Hesselbach has observed, if the fascia iliaca be torn by the pressure of the tumour, the rupture may be strangled in the aperture thus formed. Should an operation ever be required in such circumstances, it must be borne in mind that the circumflex ilii artery may be in some danger.

As a femoral hernia passes out through the crural ring, it comes into very close relation to the femoral vein, being separated from the vessel merely by the septum which divides the inner from the middle compartment of the femoral sheath. Were it not for this septum, as Roser has observed, the femoral vein would be compressed by the tense hernial tumour protruded between it and Gimbernat's ligament, and the inevitable consequence would be œdema of the whole lower extremity. As the hernia pushes down in the track of the crural canal, it can make no impression on the inner or on the posterior wall of the canal—both of which are unyielding; but, pushing the anterior wall upwards, it drags upon the septum on the outer side of the neck of the sac, renders this tense, and thus saves the femoral vein from compression.

Diagnosis.—The diagnosis of femoral hernia is not always easy. When the hernia is large, and more particularly when it rises up above Poupart's ligament, which some herniæ, even of very moderate size, are apt to do, it might at first be mistaken for an inguinal rupture. The diagnosis, however, may usually be effected by ascertaining the relation that the neck of the sac has to

Poupart's ligament, the inguinal hernia being situated *above*, the femoral *below* this cord. When, however, a small femoral hernia in a fat man rises upwards, so as to lie over Poupart's ligament, it resembles very closely an incomplete inguinal hernia ; but its characters may be determined by the passage of the finger up the inguinal canal, which will be found to be free, and the hernia can be felt only through its posterior and inferior wall. In the female the finger cannot be passed up the canal, but the inguinal hernia will descend into the labium, and may thus be recognized from the femoral, which lies in the upper and inner part of the thigh. In both sexes the relation of the neck of the sac to the spinous process of the pubes, which can always be felt in the fattest subjects, is most important from a diagnostic point of view. In femoral hernia the spine is to the inner, in inguinal hernia to the outer side of the protrusion ; and, should a patient happen to be the subject of both inguinal and femoral hernia on the same side, the spine would be felt between the two. After reducing a femoral hernia, the finger can sometimes be pushed into the inferior aperture of the crural canal, when the situation and sharp outline of the falciform process will determine the nature of the opening through which the protrusion has occurred.

The diseases occurring in the groin, with which femoral hernia may most readily be confounded, are—1. *Enlarged Lymphatic Glands* in this situation. From these it may be distinguished by the absence of impulse in the glandular tumour, and by the simultaneous enlargement of several glands. A small strangulated hernia may, however, co-exist with these ; being covered in by them. When this is the case, and the local signs of hernia are obscure, whilst the symptoms of strangulation continue, an incision should be made into the part, and the dissection carefully carried through and underneath the glands, with the view of determining whether the hernia exist or not. 2. *A small Fatty Growth* has been met with in the crural canal, closely simulating a hernia. The want of impulse on coughing, together with the doughy character, of the tumour, will enable the Surgeon to distinguish it from hernia. 3. *Psoas Abscess*, as it leaves the abdomen external to the vessels, can rarely be confounded with hernia. It may be further distinguished by its fluctuating feel, by its soft yet semi-elastic character, and by the general history of the case. The impulse on coughing, which is very distinct in the abscess, is commonly more forcible and direct than that of a hernia ; and although the purulent collection may in many cases be squeezed back into the abdomen when the patient lies down, yet it returns without a gurgle, and without that distinct slip which accompanies the reduction of a hernia. 4. *Varix of the Saphena Vein* is in some danger of being confounded with hernia. It may, however, be distinguished from this by the impulse in it being less distinct than in hernia, and by the enlargement of the lower part of the vein being marked in the varix, but not existing in the rupture.

Femoral hernia most commonly occurs in women, and very seldom under the age of twenty ; differing in both these respects from the inguinal rupture. Sir A. Cooper states that he had seen only three cases under the above age. It very seldom becomes strangulated at an early period of life, even when existing. I have had under my care a girl of nineteen with femoral hernia, in whom strangulation had already occurred on four occasions; reduction, however, having been happily effected each time.

Treatment.—The treatment of femoral hernia, when it is reducible, must be conducted in the ordinary way by the application of a proper truss. A cure, however, is never, I believe, effected by the pressure of a pad, as sometimes happens in inguinal hernia; owing probably to the rigidity and incompressibility of the tendinous and aponeurotic structures through which this rupture protrudes. It is often difficult to keep this form of hernia up by means of a truss. The best instrument for this purpose is the Mocmain truss, which I have found to succeed when all others have failed. When the hernia is irreducible, it should be supported by a truss with a concave pad.

Treatment of Strangulated Femoral Hernia.—When a femoral rupture is strangulated, reduction should be effected either by taxis or by operation as speedily as possible, gangrene ensuing more rapidly in this than in any other form of hernia. In attempting taxis, the structures in the groin should be well relaxed by flexing the thigh upon the abdomen, and abducting it, which relaxes the margin of the saphenous opening; if it do not succeed with the assistance of the means recommended at p. 813, Vol. II., the operation should be proceeded with at once. In a large proportion of cases it is possible to relieve the strangulation without opening the sac, as the stricture is most often occasioned by the pressure of the sharp edge of Gimbernat's ligament. Most Surgeons recommend that this should be divided, but some advise that the division should be made at the junction of Gimbernat's and Poupart's ligaments, dividing at the same time the fibres of the superior cornu of the falciform border of the saphenous opening which are attached to Gimbernat's ligament, and were first described by Hey, under the name of "the femoral ligament" (1803). Hey, subsequently (1814), dropped this designation, but these fibres are still sometimes called "Hey's ligament."

It is in this situation that both Lawrence and Hey recommended the incision to be made. In operating for femoral hernia, I have certainly most frequently found the stricture still to continue after the division of these ligamentous structures, and to be occasioned by the deep crural arch which forms in many cases a very distinct narrow and glistening band lying across the neck of the sac in the fascia propria of the hernia; and I agree with Sir A. Cooper that the neck of the sheath is the common seat of strangulation in femoral hernia. The bands forming the deep crural arch are probably thickened in old herniæ from the pressure of the truss and the contents of the sac. In order to expose them it is commonly necessary to draw the neck of the sac well down, when they will be seen deeply to indent and constrict it.

In operating for strangulated femoral hernia with proper antiseptic precautions the danger is in no way increased by opening the sac; but should the Surgeon be obliged to operate in an emergency without the means of carrying out efficient antiseptic treatment, it is wiser if possible to relieve the stricture without wounding the peritoneum.

The Operation without opening the Sac may be most conveniently performed when the tumour is small by making an incision by transfixion along the inner side of its neck. If the tumour be of considerable size some Surgeons prefer to expose it more freely by an ┐-shaped incision, the vertical limb of which passes along the inner side of the sac and the horizontal limb parallel to Poupart's ligament and immediately below it; but this extensive incision is rarely if ever necessary. In whichever way the first incision be made the dissection must next be carried through the superficial fascia, and the cribriform fascia, when the fascia propria (crural sheath and septum crurale fused together) will be exposed; in some cases, especially if the hernia be a large one, this is thin, and requires to be carefully slit up on a director. In many instances, however, it is so dense, laminated, and changed in structure, as scarcely to be recognised for what it is. It not unfrequently happens that, after the superficial fascia has been divided, an oval, smooth, and firm body is exposed, which at first looks like the hernial sac, or a lump of omentum; this is in reality the fascia propria, thickened by the long-continued pressure of the truss, and congested perhaps by the attempts at reduction; and in the midst of it, the sac will at last be found, after the dissection has been carried through several layers of this tissue. Cysts containing bloody serum may occasionally be found in it, and then the difficulty in the recognition of the structures is greatly increased. Though the mobility of this mass, the facility of tracing its neck, and the roundness of its general outline, often cause it to be mistaken for sac or omentum, it may be distinguished from the first by the absence of the characteristic vessels upon its surface, and from the second by its more rounded, solid feel, and uniform appearance. The sac having been clearly exposed, the point of the finger should then be carried to the inner side of this, well under the fascia propria. The finger-nail or a flat director may then be insinuated under the sharp edge of Gimbernat's ligament, which, at the point of junction with Poupart's, may be divided upwards and inwards to the extent of a line or two by means of a hernia-knife. By this incision, not only is the edge of Gimbernat's and Poupart's ligament divided, but also the condensed and compressed fascia propria lying between the sac and the inner side of the crural arch. The reduction may now be attempted, and can often be effected; should any obstacle exist, the neck of the sac must be well drawn down and exposed, and any transverse bands belonging to the deep crural arch which may be situated upon it dissected through with the scalpel and forceps, or divided on a director. These bands are incorporated with the fascia propria; and when they are found, it is usually owing to the Surgeon not having exposed the neck of the sac sufficiently before passing his nail or director under the stricture. It is owing to the incision being confined to the constriction occasioned by the superficial crural arch only, not including, as it ought to do, the subjacent condensed fascia propria. Sometimes this condensed and constricting portion of the fascia propria is so closely incorporated with the neck of the sac, that it cannot be divided without opening the latter.

In the ordinary operation in which the *sac is opened* the early steps until the sac is reached are the same as above described. When the sac has been exposed it must be very carefully opened, there being often very little if any fluid between it and its contents; the finger-nail must then be passed under the sharp edge of the stricture, which should be divided in a direction upwards and inwards. The reason why this line of incision is universally chosen is, that it is the only direction in which the stricture can be divided without risk of inflicting serious injury upon neighbouring parts. If the section be made outwards, the femoral vein will be in danger; if upwards and outwards, the epigastric artery; if directly upwards, the spermatic cord: hence the only direction is either inwards, or upwards and inwards. If the cut be made inwards, the sharp edge of Gimbernat's ligament alone will be divided, and the crural arch not sufficiently liberated. But if the division be made upwards and inwards, the tension of the whole of the arch is lessened; the only danger that can occur from the division of the stricture in this direction is the very remote one of wounding the obturator artery, when it takes the anomalous course round the inside of the neck of the sac. Guthrie states that he has known some of the best Surgeons in London to lose patients by hæmorrhage after the operation for femoral hernia. This accident, however, is of extremely rare occurrence, and might in a great measure be guarded against by slightly blunting the edge of the hernia-knife before dividing the stricture, so that the tense fibrous bands constituting the constriction would yield, while the artery would probably escape, being pushed before the blunted edge. I have, however, more than once seen blood well up rather freely on the division of the stricture; but it has ceased spontaneously, and I have never known it to give any trouble. If the division of the stricture be limited to a line or two, there will be but little danger of wounding the vessel, even when it takes the abnormal course.

The best means of arresting the bleeding from a wound of an abnormal obturator can hardly be said to be certainly determined. A. E. Barker, to whom this accident happened in operating on a patient in University College Hospital, successfully arrested the hæmorrhage by pressure, the patient dying from gangrene of the gut four days after. In a case recorded by A. H. Corley, of Dublin, the bleeding was very free, but was easily controlled by passing the forefinger into the wound and grasping the abdominal wall between it and the thumb. A curved needle was accordingly passed in through the ring and out immediately above Poupart's ligament, and a twisted suture applied around it. The hæmorrhage ceased, and did not recur. The patient died from other causes, and the *post-mortem* examination showed the obturator arising from the epigastric and cut opposite the neck of the sac. The two ends had retracted one inch apart, the distal having gone so far in the direction of the obturator foramen that any attempt to reach it would have been out of the question. The needle was found to have passed immediately in front of the proximal end, crossing the track of the artery, but not actually including it; yet the traction so exerted seems to have been enough to close the vessel, as it was obliterated by a clot. The distal end contained no clot. Bartley, in the Annals of Anatomy and Surgery, 1881, records a case in which he successfully ligatured the vessel after enlarging the wound sufficiently to bring it into view. The patient recovered. Barker, who collected the records of 16 cases of this accident, states that in 6 a ligature was applied. Probably the best means would always be to enlarge the wound up to Poupart's ligament, and attempt torsion or ligature. The artery might also be exposed by an incision above Poupart's ligament, like that for ligature of the external iliac by Cooper's method, if simple enlargement of the wound did not bring it into view. If these means fail acupressure or pressure may be resorted to.

It will generally be found that the intestine contained in the sac of a femoral hernia is dark-coloured and tightly nipped; it requires to be treated in accordance with the general principles already laid down.

Radical Cure of Femoral Hernia may be undertaken as a part of the operation for the relief of strangulation, or as an independent proceeding. The plan most commonly adopted is to draw the sac well down after ascertaining that it is really empty, and then to apply a carbolised silk or catgut ligature as high up as possible. If the sac, as often happens, can be freed from the surrounding tissues with but little dissection, it may then be cut off; or if it be more adherent, its neck may be divided below the ligature, and the fundus left *in situ.* Macewen treats it in much the same way as in his operation for the cure of inguinal hernia. The pad formed by the folded sac is placed on the abdominal surface of the ring, and secured by a catgut suture. The closure of the ring by sutures is more difficult than in inguinal hernia, owing to the rigidity of the parts concerned. John Wood has, however, devised the following method. The sac having been ligatured and cut off and the stump allowed to retract through the ring, a needle similar to that used in the subcutaneous operation for inguinal hernia is passed through the pubic portion of the fascia lata, just internally to the femoral vein, which is carefully protected by the finger. The point of the needle is then carried upwards and forwards, across the crural canal, and is made to penetrate Poupart's ligament, and then brought out at the upper end of the wound. It is then threaded with silk, kangaroo tendon, or catgut, and withdrawn. Having been freed from the ligature the needle is then passed again through the pubic portion of fascia lata in a direction inwards and forwards, so as to skirt the border of Gimbernat's ligament, and again penetrate Poupart's ligament and appear in the wound. The upper end of the ligature is next passed through the eye of the needle, which is then withdrawn. The two ends are then tied firmly in a reef-knot. The result is to close the ring by the approximation of the inner end of Poupart's ligament to the pubic portion of the fascia lata. If the ring be very wide, a third ligature may be placed through the same parts between the other two. It is somewhat doubtful whether these sutures will not cut out very soon after their insertion, owing to the tension of the parts, and further experience is required to determine whether anything is gained by their insertion. The results of the simple ligature of the sac and of Macewen's method have as far as they have been recorded been very satisfactory, a radical cure resulting in a large proportion of cases.

UMBILICAL HERNIA.

By **Umbilical Hernia** or **Exomphalus** is meant a protrusion through the umbilical aperture. It occurs either in children or in adults.

Umbilical Hernia in Children is sometimes *congenital.* At an early period of fœtal life, a great part of the intestinal canal lies without the abdomen, and is gradually drawn in as development advances. Congenital umbilical hernia or true exomphalus is the result of an imperfection in this process. In other cases a diverticulum from the ileum, due to an imperfect closure of the ductus vitello-intestinalis, may extend some distance up the cord from the navel. In either of these conditions it may happen that the protrusion is included in the ligature applied to the umbilical cord. If a large portion of intestine be strangulated in this way, a fatal result usually follows ; but if it be merely a diverticulum, the stump of the cord may separate safely, the opening in the gut being obliterated. In other cases a fæcal fistula may form at the umbilicus.

Umbilical hernia occurs more frequently shortly after birth in consequence of the child straining and crying, forming the condition termed by nurses "starting of the navel." In this form the umbilical cicatrix yields, the natural depression being completely replaced by the projection of the hernia. It is readily recognized by a smooth, rounded, and tense tumour, starting forwards at the umbilicus, readily reducible on pressure. The *treatment* should consist in the application of a small pad, made of a slice of cork, wrapped in a soft piece of lint and powdered with starch. This must be secured in position by a circular piece of soap-plaster spread on amadou or of the American rubber-plaster. An elastic belt with an air-pad is sometimes recommended, and may be applied to older children, but in infants it is quite useless, as the variation in size of the abdomen, according to the amount of flatus in the intestines, is such that no bandage can be really efficient. It most commonly happens that, after pressure has in this way been kept up for some months, a radical cure results. These small herniæ are never strangulated, and consequently never cause death ; yet it is very rare to see one in a child of ten years of age, though in infants we meet with them by the score.

Umbilical Hernia in Adults most frequently occurs in women, especially those who have borne many children, or who are loaded with internal fat. It is by no means unlikely that a tendency to this disease is often established in childhood, but does not become developed until the abdominal muscles have been relaxed by the pressure of the gravid uterus. The hernia in adults does not as a rule stretch the umbilical cicatrix in the skin. This is usually clearly recognizable at the lower part of the tumour, the hernia most commonly escaping through the upper part of the umbilical aperture.

Umbilical rupture generally attains a considerable bulk, and often acquires an enormous size ; when large, it is commonly irregular or semilunar in shape, sometimes appearing to be composed of several distinct tumours. It is usually partly doughy and partly tympanitic to the feel, has a distinct impulse on coughing, and is readily reducible ; not unfrequently, however, it happens that a portion of the rupture continues irreducible, owing to the existence of adherent omentum. The coverings of an umbilical rupture are usually extremely thin, consisting merely of the peritoneum, a layer of condensed fascia which is often perforated at several points by circular openings through which the hernia protrudes, and the integuments which are expanded over the part, and in which the umbilical cicatrix is usually clearly perceptible. The sac generally contains both intestine and omentum, but the stomach and other viscera have been included in it ; and Murray has recorded a case in which the gravid uterus, at the eighth month of pregnancy, formed the contents of an umbilical hernia.

Treatment.—The treatment consists, if the hernia be reducible, in wearing a properly constructed truss ; if irreducible, in applying a hollow cup-shaped pad supported by a bandage over the part. It not unfrequently happens that, in consequence of an indigestible or flatulent meal, an irreducible umbilical rupture in old persons becomes obstructed, the symptoms consisting of tension of the protrusion, with nausea and constipation. In these cases, much discrimination will be required to avoid confounding this passive condition of the tumour with acute strangulation of it. This may be done by attention to the rules laid down (p. 804, Vol. II.). By fomentations, and enemata, relief may usually be afforded. Should, however, the bowels not speedily act, and stercoraceous vomiting come on, the tumour continuing irreducible, it will be better to cut down upon it, and treat it as a strangulated hernia, dividing adhesions, and reducing the swelling ; for, if it be left obstructed and unreduced, the whole tumour may run into a state of gangrenous inflammation, and then operative interference will be of little use. In such circumstances death usually results ; but I have known the patient to survive the gangrene, the whole of a coil of intestine, the sac, and much mesentery and omentum sloughing away, and an incurable artificial anus resulting.

When an umbilical hernia becomes strangulated, as often happens in old irreducible tumours of this description, the symptoms are not usually very acute at first; but no time should be lost in effecting reduction, if possible, by taxis, as they speedily assume an active and urgent character. If taxis fail, a large umbilical hernia may sometimes be reduced by the application of the elastic bandage. This must be carefully applied round and over the tumour. The gentle and uniform pressure exerted by it may displace some flatus, and thus the contents of the hernia may gradually be emptied and the protrusion reduced. If this fail and the symptoms are not acute, small doses of opium may be given, and an ice-bladder applied, and kept on for a few hours. Taxis may then be again employed, when reduction of some portion of the swelling will usually follow. Should this not succeed, the operation must be proceeded with without further delay, lest gangrene set in. If the symptoms are from the first acute, the same rules apply to umbilical as to other herniæ, not to waste time with inefficient means, but to try taxis under an anæsthetic, and failing to reduce to operate immediately.

Operation.—The parts covering an umbilical hernia are usually very thin in places, so that much caution is required in making the early incisions. The stricture should, if possible, be divided without opening the sac. This may usually be accomplished by drawing the tumour well down, and then making an incision in it about two inches in length over the neck at its upper part in the mesial line. If the tumour overlap here, it may be more convenient to make the incision by the side of the umbilical cicatrix; but as a general rule, the upper part is the best. After the division of the integumental structures, and often of a deep layer of fat, the end of the nail may be slipped under the edge of the sharp circular aperture through which the protrusion has occurred, and, the stricture being divided away from the sac, and if possible in the mesial line, reduction may be readily and safely accomplished. Should the strangulation not be thus relieved, the sac must be opened, and any stricture divided from within.

The operation for umbilical hernia was formerly extremely fatal if the sac was opened, especially when the protrusion was of great size. Death usually took place from septic peritonitis. The well-known danger of the operation formerly produced considerable hesitation on the part of the Surgeon, and perhaps tempted him to lose time over inefficient means, and this may have been another cause of the excessive mortality. The risk is now greatly diminished by the use of antiseptics, and if the operation be performed early the death-rate is not greater in umbilical than in other forms of hernia. Sometimes, after the external division of the stricture, it will be found that there is an internal strangulation in the hernia, the gut having slipped through an aperture in the omentum; if so, the edge of this sharply defined opening may require division. Sir A. Cooper mentions an umbilical hernia forming two tumours, having a communication between them; and South relates a case in which the tumour resembled a figure of 8, a dense areolar band binding down the middle of the sac. In such cases as these, which are by no means uncommon, central constriction may require to be divided as well as the stricture at the neck of the sac. Adherent omentum had, I think, better be left in the sac in cases of umbilical hernia; and gangrenous intestine or omentum must be treated upon general principles. It is not often that strangulation of an umbilical hernia occurs during pregnancy, but, should it do so, the operation must be performed as usual; this condition does not complicate the case much, and instances are recorded by Sir A. Cooper, Sir W. Lawrence, and others, of its successful performance at this period. After division of the stricture and reduction of the parts, the wound must be closed by sutures, a drainage-tube being introduced and an antiseptic dressing put on, over which a broad flannel roller may be firmly applied.

Radical Cure of Umbilical Hernia.—This, as already stated, is usually effected by the pressure of a simple pad in infants and children. The herniæ of adults usually occur in fat, flabby women, who are bad subjects for any operation, and consequently it is in but a small proportion of cases that the operation is justifiable. Adherent intestine in the sac is a serious complication, and is sufficient to render the operation inadvisable. If the omentum only is adherent and the gut reducible the operation is more practicable. If the hernia be very large it is not wise to operate as, even if the patient survived the operation, the cure would almost certainly not be permanent. In cases of strangulated hernia, if the tumour be of moderate size and uncomplicated by adherent intestine, and if the patient be otherwise in good health, the operation may be completed by an attempt to effect a cure, but in large herniæ in fat, old and unhealthy women the operation should be limited to that necessary for reduction of the gut. Lastly, no operation for radical cure should be attempted without the most efficient antiseptic precautions.

For the radical cure of umbilical hernia by the open method the plan recommended by A. E. Barker is most efficient. The hernia being drawn well over to one side, an incision is carried from above downwards, crossing the neck of the tumour at a distance from the abdominal wall equal to about half the diameter of the ring. A corresponding incision is then made on the opposite side. The sac is now opened on one side, and the contents reduced. If the omentum is adherent to the sac it must be ligatured in separate pieces, cut through, and the stump reduced into the abdomen. A sponge with a string attached to it is then passed through the ring into the abdomen so as to prevent the escape of the intestines and the accidental entrance of blood into the abdominal cavity. The ring is then closed by a row of stout carbolised silk sutures, including about half an inch of the margin on each side. When the necessary number have been inserted, the sponge is withdrawn and the sutures tightened and cut short. The ring is thus closed, and the rest of the operation is practically extra-peritoneal. It consists in separating the sac from the skin around the base of the tumour and cutting through its neck about three-quarters of an inch from the row of stitches already closing the ring. The sac and the skin included in the first incisions are thus removed with the adherent omentum if any is present in one mass. Another row of fine silk stitches is then inserted, uniting the edges of the divided sac, and including a small piece of the sheath of the rectus from each side. Finally the skin is united by a row of superficial sutures, and a drainage-tube inserted. If all goes well the wound unites by the first intention, the two rows of deep sutures becoming enclosed in the scar. Some Surgeons have practised an incision in the middle line with subsequent removal of the sac and the redundant skin, but by this method the sac is opened at a point where it is often inseparably blended with the thin cutaneous covering, which increases the difficulty of isolating it for removal. Catgut sutures have also been used to close the ring, but their early absorption may lead to a return of the hernia before the scar is solid. Kangaroo-tendon is, however, free from this disadvantage.

VENTRAL HERNIA.

By **Ventral Herniæ** are meant those protrusions of the intestine that occur through any part of the abdominal wall, except the inguinal, the femoral, or the umbilical apertures ; they most commonly occur in the mid-line between the recti muscles, the linea alba appearing to have given way in this situation during parturition ; and here they may attain an immense size. A case was once sent to me from the country, in which there was a long triangular gap through the upper part of the abdominal wall, extending from the umbilicus to the ensiform cartilage, through which a protrusion had taken place that was nearly as large as an adult's head. These ruptures have also been met with in the lineæ semilunares, and in the hypochondriac and iliac regions ; and Cloquet describes a case occurring in the lumbar region. When these herniæ form in the vicinity of the stomach, they are apt to occasion dyspeptic symptoms and much gastric irritation. These different protrusions have occasionally been met with as the result of injuries, by which the anterior abdominal wall has been lacerated ; indeed they seldom take place below the umbilicus, unless arising from a directly traumatic cause, such as an ovariotomy wound.

Treatment.—The treatment of ventral hernia must consist in supporting the tumour by means of a broad belt and properly constructed pad. Should it become strangulated, which I believe very rarely happens, owing to the width of the neck of the sac, the operation must be performed in the same way as for umbilical rupture, care being taken to divide the integuments cautiously, any aponeurotic investments, and the peritoneal sac if necessary ; the stricture should always be divided upwards. In suitable cases a radical cure may be attempted by an operation similar to that for umbilical hernia.

A rare kind of ventral rupture has been described by Guthrie, in which, after a blow, the muscles of the abdominal wall have been absorbed or have yielded to a considerable extent, forming a broad and expanded tumour, without any distinct neck or pedicle. Sometimes this tumour may attain an immense size, stretching perhaps down to the knees, and containing even the gravid uterus.

PELVIC HERNIÆ.

Obturator Hernia.—This rare form of hernia, in which the protrusion of intestine takes place through the thyroid foramen, was first noticed by Garengeot, in the early part of the eighteenth century ; and, since that time, about eighty cases have been recorded. Its existence has rarely been ascertained before death ; in fact Lawrence doubted the possibility of recognizing the complaint during life, in consequence of the small size which the tumour attains, and its being covered in and compressed under the pectineus muscle. But several cases are on record in which it was recognized during life. It generally occurs in persons above the age of fifty ; in consequence, according to Gurlt, of the participation by the muscular structures covering the thyroid foramen in the general wasting of tissue which may occur at that time of life. Pimbet, who has collected the records of all the published cases up to 1882, states that in 73, in which the sex was mentioned, 65 were women and 8 men.

Symptoms.—In obturator hernia the neck of the sac lies behind the horizontal ramus of the pubes. The symptoms have in some cases sufficiently resembled those of strangulated femoral hernia to lead able Surgeons to suppose they had to deal with the latter affection. In addition, however, to the ordinary symptoms of strangulation, there are two special signs which may lead to the suspicion of the existence of this hernia, if not to its positive diagnosis. The first of these is a slight fulness and hardness in the upper part of the thigh to the inner side of the femoral vessels, often very indistinct, yet giving to the surface of the limb a different outline from that which is observed on the other side. The other is, pain extending down the inner side of the thigh towards the knee; or even, as in a case referred to by Birkett, as far as the great toe. This pain has been noticed in a large number of the recorded cases, and is due to the pressure of the hernia on the obturator nerve: it may also be increased by pressure with the hand over the thyroid foramen, and according to Pimbet by forced external rotation of the limb. It does not extend to the testis; but it may, as happened in a case which I have seen, affect the thigh to such an extent that the patient, to relieve it, flexes the limb on the abdomen. Roser has recommended, as a means of diagnosis, an examination of the interior of the pelvis, *per rectum* in the male, and *per vaginam* in the female. Most reliance, however, is to be placed on the symptoms which I have described.

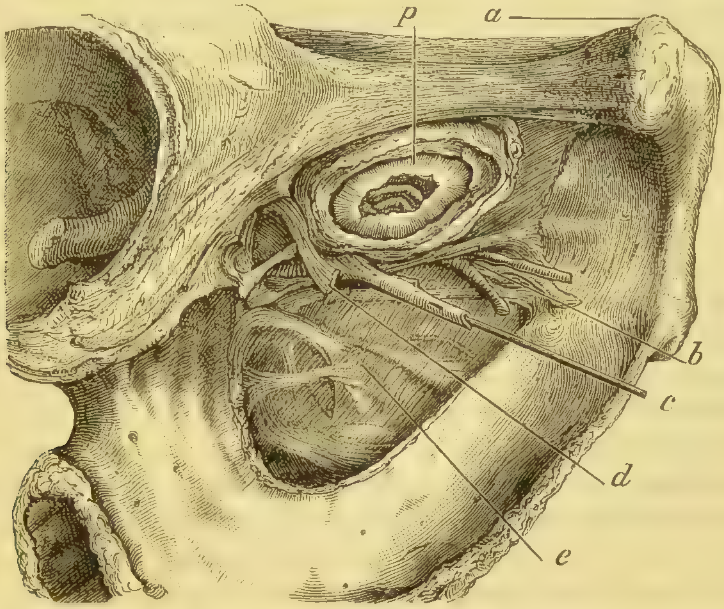


Fig. 819.—Obturator Hernia: *a.* Pubic Spine; *b.* Branches of Obturator Veins; *c.* Obturator Artery with a glass rod in it; *d.* Obturator Nerve; *e.* Obturator Membrane; *p.* Sac of the Hernia opened.

Treatment.—Taxis has been employed in a few cases. In one instance, Roser reduced an obturator hernia in this way, the patient surviving; but, in another case under his care, death took place, a portion of the walls of the intestine remaining strangulated. Werner was successful in an instance in which, in addition to applying pressure externally, he introduced his hand into the vagina, and employed traction backwards and upwards. Welsch of Herrenberg reduced an obturator hernia by external pressure; the patient was apparently doing well, when, in a few days, an abscess appeared at the site of the hernia, and he died in seven weeks. At the *post-mortem* examination, the end of the vermiform appendix was found projecting through the thyroid foramen, with its tip laid open by the suppurative process.

In thirteen cases of which I can find records an operation was performed, followed in three cases by recovery and in ten by death. The recoveries occurred in the practice of Obre, Bransby Cooper, and Lorinser of Vienna; and the deaths in cases operated on by Heath of Newcastle-on-Tyne, Nuttall of Leicester, Heilberg and Zahrtmann, Arntz of Ringkjöbing, Ulrich and Wilms of Berlin (two cases), Szigmondi of Vienna, Grünberg and Godlee. In Obre's case, the patient was seized with symptoms of strangulation, but no tumour could be detected in any of the ordinary seats of hernia. "On uncovering the upper part of both thighs at the same time, the eye detected a slight degree of fulness in Scarpa's triangle on the right side; this triangle of the opposite limb was well marked with a hollow, or depression passing down its centre, but this was lost on the affected side, and the whole contour of this part of the limb was visibly fuller than that of the corresponding one. There was no tumour or circumscribed swelling; but, on standing over the patient, and using firm pressure with the ends of the fingers over the neighbourhood of the femoral artery, and a little below the saphenous opening, a distinct hardness could be felt (slight in its extent), giving an impression as if the sheaths of the vessels were being pressed on." Taking the dangerous state of the patient into consideration, Obre acted in accordance with the best rules of surgery; and, thinking that there might be a hernia deeply strangulated in the femoral canal, he made an incision downwards in this situation, but was disappointed on finding, when the saphenous opening was exposed, that there was no intestine confined there. As, however, a hard structure could be felt deeply at the inner border of the opening, the fascia lata was exposed, and the pectineus muscle divided to the extent of about two inches, when a hernial sac of about the size of a pigeon's egg, and containing intestine, came into view. In this operation the saphena vein gave some trouble, lying in the course of the incision. The sac having been laid open, the stricture was divided upwards, during which part of the procedure the vein was accidentally cut, and required ligature; no other vessel was tied. The operation was perfectly successful. In Bransby Cooper's case, the patient, a woman aged forty-nine, recovered from the operation, but died of bronchitis before leaving the hospital. In Lorinser's case, the existence of the hernia was detected by vaginal examination. On cutting down on the hernia (on the eleventh day of the symptoms) the intestine was found gangrenous. A fæcal fistula resulted, but subsequently closed; and the patient survived eleven months, dying at last of tuberculosis. In Szigmondi's case the patient died from dysentery some time after the operation. In another case operated on by Grünberg, the patient died on the twentieth day of perforation of the intestine. In 1884 R. J. Godlee operated on a case in University College Hospital by an incision in the middle line of the abdomen. The hernia was reduced without difficulty, but the patient, who was extremely collapsed at the time, died about twenty-four hours after the operation.

The results of these cases show that occasionally the local indications may be sufficient to guide the Surgeon to the seat of the hernia, and when this is the case there should be no delay in operating by the method adopted by Obre. The stricture must be divided directly downwards, as the artery is most commonly above the sac. If, however, the indications are very uncertain, it is better to perform laparotomy, and if an obturator hernia be found, to reduce it from within.

Besides the obturator, various other pelvic herniæ may take place, as into the perinæum, the vagina, or through the sciatic notch. These various forms of rupture are of extreme rarity, and present many difficulties in their diagnosis.

Perineal Hernia commonly occurs in the middle line, between the rectum and the bladder in men, or the rectum and vagina in women; but sometimes the protrusion has been known to take place by the side of the anus. Of these various forms of rupture, many instances have been collected by Lawrence from different writers. The *Treatment* of such a hernia would consist in supporting the protrusion by means of a pad and bandage; as the mouth of the sac is very large, strangulation is not probable.

Vaginal Hernia has occasionally been met with; the tumour protruding through the posterior or upper wall of the vagina, and presenting the ordinary characters of this disease, such as impulse on coughing and reducibility. It must be kept up by means of a pessary.

Pudendal Hernia has been described by Sir A. Cooper as very closely resembling vaginal rupture. The situation of the tumour may cause it to be mistaken for an inguinal hernia; but from this it may be recognised by the upper part of the labium and the ring being completely free, whilst a tumour presenting the ordinary characters of a rupture is situated in the lower part of the labium, and forms a prominence along the side of the vagina.

Sciatic Hernia.—This rare form of hernia has been described by Sir A. Cooper as passing through the sciatic notch, where it lies between the lower border of the pyriform muscle and the spine of the ischium. It lies in close relation with the sciatic nerve, and with the internal iliac vessels. In the case related by Cooper, the obturator artery passed above, and the vein below the neck of the sac. From the depth at which such a hernia would be seated, and its small size, it would probably escape observation during life; but, if detected, it might readily be retained by means of proper bandages and a pad. Should operation ever be required, laparotomy and reduction from within the abdomen would probably be the safest proceeding.

DIAPHRAGMATIC HERNIA.

Congenital defect of the Diaphragm is occasionally met with. It has consisted, in most of the recorded cases, of an aperture in this membrane, varying in diameter from an inch upwards; and amounting, in some rare instances, even to an entire absence of one or both wings of the diaphragm. Through these openings, the contents of the abdomen have been protruded; the stomach and small intestines being most frequently displaced, and the spleen and liver having been found in the chest in a tolerably large proportion of the cases. The hernia has been mostly observed in children at or soon after birth; but in several instances the subjects have lived to adult age, the hernia at last taking place apparently accidentally. In some of these latter cases, however, it may be a question whether the opening in the diaphragm was not the result of an accident, perhaps some time antecedent to the occurrence of the hernia. The opening has generally been found on the left side; sometimes, however, on the right.

Diaphragmatic hernia is sometimes of **traumatic** origin, being the result of a wound or laceration of the diaphragm. It usually attains a large size, and may contain the stomach or the transverse colon with a portion of the omentum, which forms a tumour in the thoracic cavity, encroaching upon the lungs, and pushing the heart to one side. The hernia is not enclosed in a peritoneal sac, but has been found partially enveloped by the pleura. It occurs generally on the left side of the chest, but cases have been recorded by Percy and others where the injury of the diaphragm was on the right side. The following case is a very good instance of this rare affection.

A man, seventy-four years of age, was admitted into University College Hospital. About twelve months before, he had fallen into an area about ten feet deep ; he believed that he had injured his chest and head, as from that time he had suffered much from shortness of breath and occasional sensation of suffocation, had a hacking cough, and could not lie down without feeling some difficulty in breathing. At the time of the accident, he coughed up about three spoonfuls of blood. Ever since the accident, he had suffered much from dyspeptic symptoms and constipation, though before he met with the injury he had experienced no inconvenience in this respect. About a month before admission, the difficulty in breathing increased ; and four days before he came to the hospital, violent pain in the abdomen came on, and his bowels ceased to act, although he took a variety of aperient medicines, and had enemata containing croton oil. On admission, the abdomen was much distended, tense, and tympanitic, with pain around the umbilicus ; the tongue was coated with whitish-brown, moist fur ; the pulse was small, quick, and somewhat resisting ; there was nausea, but no vomiting. The skin was cool, and the countenance anxious ; the bowels had not acted for seven days, but he had frequent desire to go to stool. He was ordered an aperient draught every third hour. As this had no effect, he was directed to take calomel and elaterium pills, and to have turpentine enemata, which afforded him some relief, though they brought away no fæces. The patient became more restless, the skin cold and flabby, the countenance more anxious, the breathing shorter, and the abdomen more tympanitic, and he died two days after admission, and nine from the commencement of the obstruction.

Examination of the Body twenty-four hours after death.—The abdomen was distended and tympanitic, and the peritoneal sac contained about six ounces of fluid, with here and there patches of recently effused lymph. The small intestines were not distended : the large were greatly distended with flatus, the cæcum extending into the cavity of the pelvis ; the ascending and the transverse colon were much distended, and it was found that a large loop of the transverse and of the descending colon had passed through an opening in the cordiform tendon of the diaphragm into the pleural sac, and was there strangulated (Fig. 820). The colon below the stricture was contracted, and entirely empty. On opening the thorax, the loop of intestine, fourteen inches in length, of a pale slate-colour, and distended with gas, was found in the left pleural sac. It reached as high as the fifth rib, touched the pericardium, and was overlapped by the free margin of the left lung. Where strangulated, it was of a darker colour than elsewhere. The opening in the diaphragm, through which it had passed, admitted little more than the point of the forefinger, and had a thin tendinous margin. The tenth and eleventh ribs, on the left side, were found to have been fractured ; the latter was united by bone, but the tenth rib, at the seat of fracture, had formed a false joint. Connected with this and with the intercostal space below it, was a firm adhesion about an inch broad and an inch and a half long, united by its other extremity to the protruded meso-colon and the diaphragm. The protruded meso-colon was firmly adherent to the upper surface of the diaphragm, close to the opening in it. The lungs were tolerably healthy. The right pleura contained three ounces, and the left eight ounces of serum.

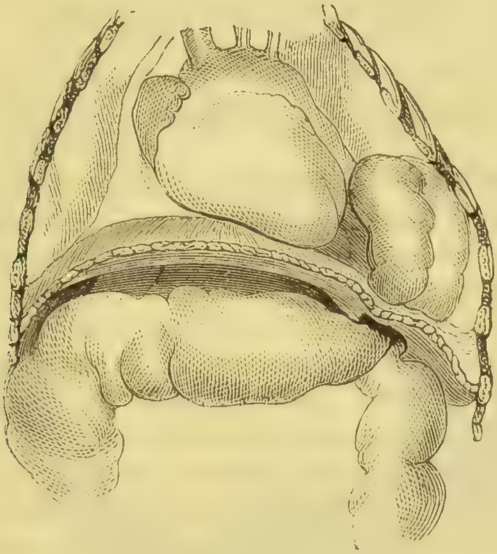


Fig. 820.—Diaphragmatic Hernia of Colon.

CHAPTER LXIII.

INTESTINAL OBSTRUCTION.

THE term **Intestinal Obstruction** as commonly used means a total arrest of the passage of fæces and flatus through the intestine, but by some writers it is applied also to interference with the free passage of the intestinal contents, and is qualified as *partial* or *complete.* Except in the case of stricture of the rectum the Surgeon has to deal solely with cases of complete obstruction, the partial form belonging rather to the physician. The term will therefore be used here to signify the complete variety only. Intestinal obstruction may arise from many pathological conditions, which it is important, if possible, to distinguish from one another, as they require different lines of treatment for their relief. Our knowledge of the various causes of obstruction of the bowels has been of late greatly increased by the work of Fagge, Bryant, Leichtenstern, and many others, and especially by the publication of an excellent monograph on this subject by F. Treves, containing besides much original matter a complete summary of all previous observations. Intestinal obstruction may be either *Acute* or *Chronic*, but this division does not agree accurately with one founded on pathological anatomy, as some forms of mechanical obstruction, especially intus-susception may run an acute or chronic course according to circumstances.

Acute Intestinal Obstruction.—The **Symptoms** common to all forms of acute obstruction are as follow. The patient who may previously have been in perfect health is seized with a more or less sudden feeling of something wrong having taken place in his abdomen, or he may be taken with *intense pain* at one point. This pain persists to a greater or less degree throughout the case, and is often violent and paroxysmal. *Vomiting* speedily follows, at first of the contents of the stomach, but after a time of stercoraceous matter. This is as a rule accompanied by an intense sense of nausea, which is not relieved by the act of vomiting. The quantity brought up is often enormous, and every drop of fluid taken is immediately returned. *Constipation* is complete, neither flatus nor fæces passing, and most commonly there is no sense of any desire to go to stool throughout the case. In most cases before long *distension of the abdomen* sets in, the intestines being filled with flatus, but as a rule in acute obstruction the tension of the belly is not very great until after the third or fourth day. If the obstruction be high up in the bowel distension may be entirely wanting. If the patient be thin, the distended coils of intestine may be recognisable through the abdominal wall, but they can seldom be seen or felt rolling upon one another, nor are gurgling or rumbling noises commonly to be heard. *Tenderness* may be found localised in one spot in the abdomen, and it then probably indicates the seat of the obstruction. If peritonitis sets in, the tenderness becomes more general, and the abdominal walls become tense and rigid. In some forms distinct *tumour* may be felt within the abdomen. The

Constitutional Symptoms are very severe, collapse setting in early. Occasionally syncope may occur at the time of invasion. The tongue is coated with a foul creamy fur, ultimately becoming dry and brown. The mind remains clear to the last. If relief be not afforded the patient rapidly emaciates, the depression increases, and death results usually under a week.

Varieties and Causes of Acute Intestinal Obstruction.—Acute intestinal obstruction may arise from—1, internal strangulation of the bowel; 2, volvulus or twist; 3, impaction of concretions or foreign bodies in the small intestine; 4, stricture of the small intestine becoming suddenly occluded, and 6, acute intus-susception.

Internal Strangulation.—This affects almost invariably the small intestine. It resembles in its main features ordinary strangulated hernia, differing solely in the fact that the cause of constriction is situated within the abdominal cavity, and not at one of the normal apertures in the wall. As a rule the strangulation is less severe in internal obstructions than in external herniæ, and gangrene of the gut is comparatively rare. In the majority of cases the constriction arises from a portion of gut slipping under or becoming entangled in a **band** passing from one part of the abdominal cavity to another. These bands are often many inches in length, usually rounded in form and from a tenth to a third of an inch in diameter. They are composed of fibrous tissue, and are often of considerable strength. From the fact that they are most commonly single, Gay described these under the name of "solitary bands." They are supposed to be formed, in many cases at least, by adhesions between two portions of the abdominal contents, resulting from localised peritonitis.

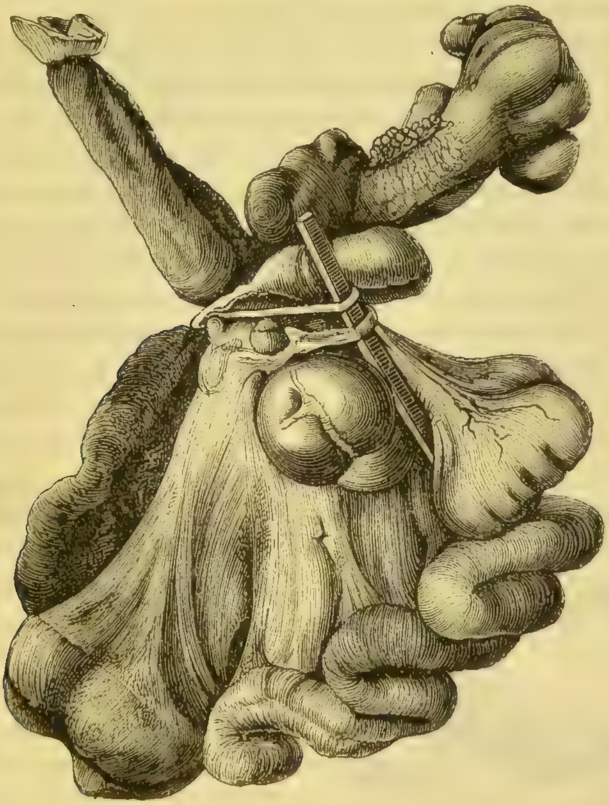


Fig. 821.—Strangulation of intestine by a band attached to a diverticulum from the ileum.

Thus inflammation of a mesenteric gland may cause the adhesion of a neighbouring part of the mesentery or of a coil of the intestine, or a typhoid or tubercular ulcer may cause the adhesion of two portions of the ileum. The fibrous adhesion thus formed is supposed to be gradually stretched and rounded by the movements of the intestines. In other cases the bands are probably congenital, especially when connected at one end with the umbilicus or its immediate neighbourhood, and at the other with the mesentery. When the band is short, strangulation usually occurs from a coil of gut slipping beneath it, but when it is long and loose, it may form a noose, in which a portion of the intestine may be snared.

Internal strangulation may also be caused by **bands formed from the omentum.** These are commonly attached near the openings of the femoral and inguinal rings, more especially in cases in which a hernia has at some time existed. The adherent piece of omentum usually loses its membranous form, and becomes twisted into a firm fibrous cord, by which the gut may be pressed upon as above described.

Meckel's diverticulum from the ileum, the imperfectly obliterated vitelline duct, is another not uncommon cause of strangulation. When this forms a free pouch-like projection from the intestine, it is not likely to cause any trouble, but its extremity may become adherent to the mesentery or to other coils of intestine, and thus form a loop through which a coil of gut may pass. In other cases the diverticulum is long and narrow with a globular extremity, and when of this form, may knot round a coil of gut. Lastly, a band not uncommonly extends from the free end to the umbilicus.

Strangulation may also arise through **loops formed by the attachment of the Fallopian tube or vermiform appendix** to neighbouring structures, such as the abdominal wall, the mesentery, the omentum, or the intestine.

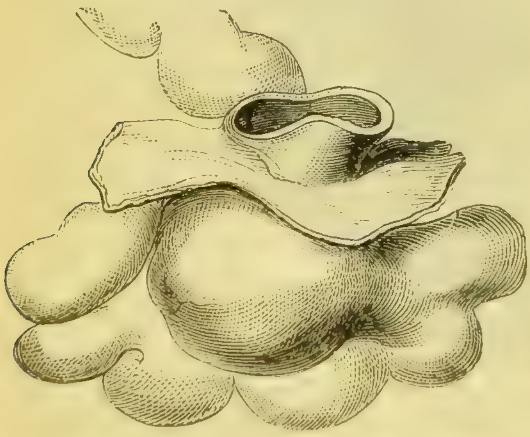


Fig. 822.—Intestinal Obstruction from Internal Hernia.

In another form the gut is strangulated by passing through a **slit or aperture in the omentum or mesentery** (Fig. 822). In some cases these openings are possibly the result of injury, but probably they are more commonly congenital.

The above are the most common varieties of internal strangulation, but various other anomalous forms are mentioned by Treves, such as strangulation over, instead of under, a band, acute kinking from traction on an isolated band, or by an adherent diverticulum, &c.

Special Symptoms of Internal Strangulation.—Internal strangulation gives rise to the most typical cases of acute obstruction. It is slightly more common in males than in females, and occurs most frequently between 20 and 40 years of age. In a considerable proportion of cases there is a previous history of peritonitis, or of obscure abdominal pains, and, in a smaller proportion, of previous attacks of partial obstruction. The onset is almost always sudden, the patient being able to tell the exact time at which he was seized with the symptoms. In a considerable proportion of cases there is some apparent immediate cause, such as running or jumping, straining at stool, or a violent action of the bowels, either as the effect of a purgative or from diarrhœa. The pain is usually severe and griping, and most commonly referred, as in ordinary strangulated hernia, to the region of the umbilicus. The vomiting sets in early, very speedily becomes stercoraceous, and is often very abundant. Constipation is complete, and there is no sense of a desire to go to stool. There is prostration from a very early period, and collapse sets in rapidly. The temperature is seldom raised; much more commonly it is subnormal. Owing to the profuse vomiting and the rejection of all fluids taken by the mouth there is intense thirst, and the urine becomes very scanty. On examination of the abdomen at first there may be no distension, and it is possible sometimes to recognise fulness and some tenderness at the seat of the strangulation. Later on more or less distension sets in, but it is not usually very excessive. Dilated coils of intestine may be recognised if the patient is thin, but no peristaltic movements are visible except in very rare cases. Percussion as a rule gives a uniform tympanitic resonance over the whole abdomen.

Cases of internal strangulation, if left to nature, very rarely recover. Yet it occasionally happens that the obstruction, even when of the most acute character, may give way. Almost invariably, however, the symptoms continue, the prostration increases, the extremities become blue and cold, the pulse more rapid and feeble, respiration shallow and hurried, and death takes place usually under a week, the patient retaining consciousness to the last. If the strangulation is very intense the ordinary symptoms of peritonitis may develop as gangrene of the gut commences, but more commonly the gut is not held sufficiently tight to cause complete arrest of circulation, and peritonitis is wanting to the end.

Volvulus.—A twist of the intestine may occur in three ways. The gut is, in very rare cases, twisted on its own longitudinal axis; much more commonly a long loop is twisted on its mesenteric axis, and again, very rarely, the neighbouring coils become twisted round each other. In whichever way it occurs the lumen of the gut is occluded, and the symptoms of intestinal obstruction set in. Volvulus may affect almost any part of the intestine, but by far the most common seat is the sigmoid flexure, so much so that it will suffice here to describe that form only. It is the only form of acute intestinal obstruction affecting the great intestine. In the sigmoid flexure it is invariably the result of great dilatation of the gut, possibly in some cases congenital, but commonly the effect of habitual constipation. In this way the sigmoid flexure may become greatly increased in length and in diameter, and the meso-colon becomes long and loose. In this condition it is easy to understand how it may become twisted on itself, either as a consequence of some movement or from accumulation of fæces in the upper part of the loop. When it becomes thus twisted complete obstruction results. The circulation in the actual twist is seriously interfered with, the gut becomes congested and almost invariably peritonitis sets in, commencing at the twist. Later on, if the patient lives long enough, sloughing and perforation may take place at the twist.

Special Symptoms of Volvulus of the Sigmoid Flexure.—The invasion is, in most cases, sudden, without severe collapse or shock, and accompanied by pain, not usually very intense, often intermittent and griping.

Distension of the abdomen sets in very early, and forms the most marked feature of the case. This is caused almost entirely by accumulation of gas in the dilated sigmoid flexure, which may become so distended as to empty and compress the other parts of the intestine, and by forcing up the diaphragm may seriously impede respiration. The huge distended coils of the great intestine may be recognisable through the abdominal wall. Constipation is complete, neither flatus nor fæces passing, but vomiting is not a very marked symptom and rarely becomes stercoraceous. Tenesmus is an occasional symptom. The course of the disease is usually rapid. Symptoms of peritonitis appear at an early period, and according to Treves, death takes place on an average about the sixth day. It has been known to occur on the third day from asphyxia caused by the pressure of the distended gut.

Volvulus of the small intestine or of the great and small together, gives rise to much the same symptoms as strangulation by a band.

Impaction of Foreign Bodies in the Small Intestine.—Foreign bodies may be divided into three classes :—

1. *Solid foreign bodies accidentally swallowed*, such as false teeth, plum-stones, &c., very rarely cause obstruction of the intestine directly, for anything which can pass the œsophagus can, as a rule, pass the remainder of the alimentary canal.

2. *Intestinal concretions or enteroliths* are of three kinds. 1. Laminated stony masses of a white or brownish colour, composed of magnesium phosphate, ammonio-magnesium phosphate, and organic matter usually formed round some small foreign body as a nucleus; 2. Masses formed of indigestible husks or other vegetable refuse felted together and mixed with fæces and earthy matter ; and 3. Stones formed as a consequence of the long-continued and excessive administration of certain mineral drugs, especially chalk, magnesia and oxide of bismuth.

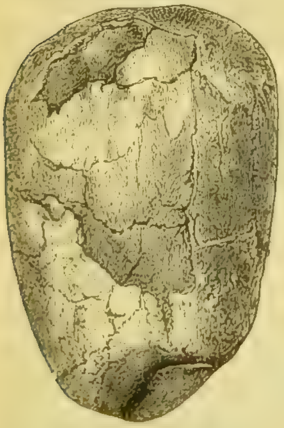


Fig. 823.—Gall-stone removed by operation from the ileum.

3. *Gall-stones* far more commonly cause obstruction than the solid bodies above mentioned, and the accident is much more frequent in women than in men. It is probable that in every case of obstruction from a gall-stone the calculus has found its way into the intestine by ulceration from the gall-bladder into the duodenum, and not by passing down the bile-duct. The shape commonly assumed by these large calculi is well shown in Fig. 823, taken from a stone removed from a case under the care of B. H. Allen of Hastings. The base of the stone is facetted as if it had lain in contact with another concretion in the gall-bladder. It is possible that the stone may increase in size after entering the intestine.

A foreign body, when it causes obstruction, usually lodges in the lower part of the ileum, which is the narrowest part of the intestine.

The **Special Symptoms of Obstruction from a Foreign Body** are not very characteristic. The previous history may throw some light upon the case. If the foreign body is a gall-stone there may be a history of repeated attacks of hepatic colic, and of an illness with obscure pain in the region of the gall-bladder, probably unaccompanied by jaundice, occurring some days or weeks before the symptoms of obstruction commenced and indicating the time at which the gall-stone passed by ulceration into the duodenum. After this there may be a history of obscure pains in the belly, usually worse after food. The invasion of the symptoms is sufficiently sudden to bring the condition within the class of acute obstructions, but it is not abrupt, nor is it accompanied by severe pain or collapse. The vomiting comes on gradually, is seldom very profuse, and may not become stercoraceous for many days. The constipation is complete, but in the great majority of the recorded cases there has been little or no distension of the abdomen. The coils of intestine cannot be recognised, nor is there any visible peristalsis. Such pain as there is may be referred to the region of the obstruction, but this is by no means always the case. By manipulation some tenderness may be detected, usually below and to the right of the umbilicus, and possibly, under chloroform, some fulness might be felt if the patient be not too fat.

The result of the case depends upon the size of the foreign body and the point at which it is impacted. If lodged high up, a very rare condition, the symptoms are much more severe and death occurs early. If low down in the ileum the patient may survive for from two weeks to a month. In other cases a gall-stone has been passed after as much as four weeks of complete obstruction. The size of the foreign body and its form are of much importance. If smooth and rounded it is more likely to pass. The stone figured above was rough on the surface, and measured $3\frac{7}{8}$ inches in circumference. Larger stones than this have been passed after longer or shorter intervals of obstruction, but on the other hand, death has been caused by a calculus measuring only $2\frac{1}{4}$ inches in circumference. If death takes place it is caused either by exhaustion from vomiting or by ulceration and perforation of the gut at the point where the body is impacted.

Sudden Occlusion of a Stricture of the Small Intestine is necessarily a very rare form of obstruction, as stricture of this portion of the alimentary canal is seldom met with. It is said, however, to occur as the result of cicatrisation of tubercular ulcers, which tend to spread circularly round the gut. Typhoid ulcers, which are longitudinal, probably never cause contraction. Syphilitic, catarrhal and peptic ulcers have also been described, but that they ever cause stricture is very doubtful. Treves mentions six cases of stricture after injury, four after strangulated hernia, and two after external violence. Cancerous stricture of the small intestine is more common than simple, but it also is very rare. Narrowing of the small intestine may also be caused by a coil being kinked and fixed in this position by adhesions, by chronic peritonitis often tubercular, causing sometimes a matting together of many contiguous coils of gut, the lumen being narrowed possibly in more than one place.

The **Special Symptoms of Obstruction from narrowing of the Small Intestine** are not very definite. The patient has usually suffered, often for years, from occasional attacks of abdominal pain, commonly described as colic. These most frequently occur after meals, especially if some indigestible food has been taken. In some cases attacks of vomiting and obstruction have occurred and passed off, perhaps ending in diarrhœa, more than once before the final obstruction. The final attack closely resembles that already described as occurring in impaction of a foreign body. If the stricture is low down, the symptoms develop less rapidly.

Stricture of the Ileo-Cæcal Valve, either simple or malignant, gives rise to the same symptoms as the same affection in the lower end of the ileum. It is a rare affection. Treves has collected 8 cases, 3 of which were simple and 5 cancerous.

Intus-susception may give rise to either acute or chronic obstruction, and as it presents many peculiar features, is best discussed separately.

CHRONIC INTESTINAL OBSTRUCTION.—A typical case of chronic obstruction is characterised by the gradual development and the want of intensity in the symptoms. The cause of this condition is seated almost invariably in the great intestine. In a few exceptional instances stricture of the small intestine has given rise to chronic obstruction, but in most of the recorded cases, as already stated, the sudden blocking of the narrowed lumen causes an attack sufficiently sudden in its commencement and rapid in its course to justify its inclusion amongst acute obstructions.

In chronic intestinal obstruction there is usually a history of gradually increasing constipation, often alternating with diarrhœa. The motions often become gradually smaller, and are not uncommonly streaked with blood and mucus, and passed with much straining. At last the constipation culminates in complete obstruction, neither fæces nor flatus passing. It may not be for some days that the patient recognises that his bowels are obstructed, and he frequently first becomes aware of it by the failure of purgatives to produce a motion, and by some sickness with distension of the abdomen following their use. After a week or more, eructations, retchings, and even vomiting may set in. The abdomen gradually becomes distended, and the flatus passing from one part to another gives rise to loud rumbling and gurgling noises, with some griping pain. The belly usually assumes a barrel shape, the flanks being distended and tympanitic. If the abdominal walls be thin, the distended coils may be felt and often seen through them, and peristalsis may be very evident. Not uncommonly the patient will say that he feels the flatus moving towards a certain point where it is obstructed in its passage, and then rolls back with a loud rumble. As the case progresses the vomiting increases in frequency, and at last, usually after two or three weeks, it may become fæculent. It is never, however, so abundant as in acute obstruction. The tongue is foul from the first, and towards the end becomes brown and dry. Loss of flesh is very evident from the beginning, and before death the emaciation may be extreme. If unrelieved by treatment death takes place at periods varying from two weeks to two months, most commonly from exhaustion, but occasionally from perforation of the bowel and peritonitis. The gut may give way immediately above the occluded point, but more commonly perforation occurs in the cæcum, even when the obstruction is at some distance from that part.

Causes and Varieties of Chronic Obstruction.—Stricture of the Large Intestine is by far the most frequent cause of chronic obstruction. In the rectum, simple, syphilitic and cancerous strictures are common, and will be described in the chapter on Diseases of the Rectum. In 44 strictures seated below the ileo-cæcal valve and above the rectum, Treves found that 28 were cancerous, 13 simple, and 3 of doubtful nature. Cancer occurs with about equal frequency in males and females, but simple strictures in this country are more common in females. In 98 cases collected by Coupland, Morris, Fagge and Treves, the situation of the stricture was as follows: sigmoid flexure, 58; descending colon, 11; splenic flexure, 7; transverse colon, 7; hepatic flexure, 9; ascending colon, 2; and cæcum, 4. The simple stricture of the great intestine is the result of the healing of some non-malignant ulcer, most commonly dysenteric, less frequently syphilitic. The malignant stricture is almost invariably a columnar carcinoma (columnar epithelioma). Colloid is said also to be occasionally met with as a result of degeneration of a columnar carcinoma. Glandular cancer probably never occurs primarily in the great intestine. Cancerous tumours in the intestine are often of very slow growth. They tend to extend circularly round the gut, and thus to narrow its lumen. Secondary growths are frequently absent throughout. When they occur they affect the lymphatic glands, and less frequently the liver. As the growth advances it invades neighbouring parts, and at the same time degenerates and ulcerates in its centre. Thus, in some cases communications have been established between the bladder and the gut, or between the great and small intestine. Perforation is very rare, as adhesions form before the growth penetrates the wall of the gut. In all cases of stricture, whether simple or malignant, the gut is dilated above the narrowed part, and its muscular coat hypertrophied, a condition which can frequently be recognised by examination of the abdomen. Ulceration of the mucous membrane immediately above the stricture is rare, but in the cæcum it is very common, even when the obstruction is seated in the lower part of the colon. The formation of these "stercoral ulcers," as they are called, is apparently the result of the irritation and pressure of the accumulated fæces.

Simple Tumours growing within the Bowel very rarely cause obstruction. Tubular adenomata and papillomata are the most common simple tumours of the intestine, but if we exclude those growing in the rectum, they are extremely rare. Fibromata, springing from the submucous tissue, fibromyomata, lipomata and angiomata have also been described, but they are merely pathological curiosities.

Narrowing of the Gut by pressure from without is a more frequent cause of obstruction of the great intestine. Under this heading may be included pressure from inflammatory products, as in pelvic cellulitis or in perityphilitic or perinephritic abscess, and invasion or compression of the gut by malignant growths in neighbouring parts, as by a cancer of the tail of the pancreas, sarcomata in the iliac fossa, &c.

The **Special Symptoms of Narrowing of the Great Intestine** are the same, whether the cause lies without or within the gut. They consist in gradually increasing difficulty in obtaining relief from the bowels. At first this is overcome by purgatives. The periods of constipation are frequently followed by diarrhœa. This alternation of constipation and diarrhœa always suggests the existence of some narrowing of the great intestine. In some cases the motions become gradually smaller, but this only occurs when the stricture is low down. In other cases the bowels act with great frequency, the motions being small in quantity and frequently loose. The passage of blood and mucus is an important sign of malignant ulceration. The patient at the same time suffers from dyspeptic symptoms, eructations, loss of appetite, and foul tongue. The complexion becomes muddy and unhealthy, and there is usually more or less loss of flesh. The abdomen becomes full, and the distended great intestine may often be recognized without difficulty. After these symptoms have existed for a longer or shorter time complete obstruction sets in with the signs already described.

Mechanism of Obstruction of a narrowed large intestine.—The final obstruction of the narrowed gut usually occurs as the result of the impaction of a hardened mass of fæces, or some indigestible material in the stricture. In other cases it apparently arises from kinking, bending, or twisting of the distended bowel above the stricture, for it is very common, after colotomy has been performed to relieve prolonged complete obstruction, for the fæces to pass freely again for some time by the natural passage.

Prognosis.—Chronic obstruction, if unrelieved, is, of course, ultimately fatal, either from exhaustion or from perforation of the gut, most commonly in the cæcum. It often happens, however, that the first attack passes off after one or two weeks' complete obstruction. This seems to arise from gradual softening of a fæcal mass impacted in the stricture owing to an abundant exudation from the irritated mucous membrane above the narrowed point. When the obstruction gives way it is usually followed by copious diarrhœa. If no relief is obtained the duration of the case may vary from three weeks to two months. Much will depend upon the treatment. If the patient is properly fed, and not poisoned by powerful purgatives, life will usually be prolonged to six weeks or more without operative interference.

Fæcal Accumulation.—Obstruction from accumulation of hardened fæces occurs with infinitely rare exceptions in the great intestine only. It is most common in women, especially in those liable to hysteria. It is merely an exaggeration of habitual constipation. The gut, from being constantly distended, becomes partially paralysed and unable to expel its contents, relief only being obtained by the use of enemata and purgatives. A large fæcal mass accumulating under these conditions becomes gradually hardened by absorption of its more fluid constituents, and by pressing on and distending the gut leads to more complete paralysis of the part in which it is lodged. These masses are most commonly met with filling the rectum and sigmoid flexure, but they are not uncommon in the cæcum, and may be arrested at any part of the colon. The **Symptoms** are less severe than in other forms of obstruction. Vomiting may not come on till a very late period, and is rarely stercoraceous. The digestion and appetite become impaired, the complexion becomes yellow or earthy, there are unpleasant eructations, a foul tongue, and offensive breath. There is some loss of flesh. The abdomen becomes more or less distended, and coils of small intestine in active peristaltic movement are sometimes visible. Under an anæsthetic, if the mass is lodged in the colon, it can be felt as a firm tumour which, on pressure, can be indented with the finger like a mass of putty. If this sign is present, it is diagnostic of fæcal accumulation, but it does not prove that there is no stricture below it. If the accumulation fills the rectum, it is recognized by digital examination. **Results.**—Fæcal accumulation is very rarely fatal. When it does cause death it is most commonly from ulceration of the mucous membrane, apparently from the pressure and irritation of the fæcal mass, followed by perforation and peritonitis. The duration of obstruction from fæcal accumulation is often extraordinary, authentic cases being recorded in which patients have recovered after having passed no motion for more than three months. *Enteroliths* have in very rare cases been known to cause obstruction resembling that by fæcal accumulations.

Intussusception, or the invagination of one portion of the intestine into another, is a common form of intestinal obstruction, especially in children. It forms about 30 per cent. of all cases. The upper portion of the intestine is invaginated into the lower. To this rule a very few exceptions have been recorded. According to Leichtenstern, 44 per cent. of all cases are seated at the ileocæcal valve, the valve itself forming the apex of the invagination. The next most frequent seat is in the small intestine, especially in the lower jejunum, 30 per cent. occurring in this region. Eighteen per cent. are met with in the rectum, and in 8 per cent. the invagination has occurred in the lower part of the ileum, the invaginated portion passing through the ileo-cæcal valve, and being grasped by it.

An intussusception, if examined after death, is found to be composed of three tubes of intestine, one within the other. The innermost tube is spoken of as the entering tube. The middle or reflected tube is turned inside out, so that its serous coat is in contact with that of the entering tube. In the space between these two tubes lies the mesentery belonging to each, and the vermiform appendix in those cases in which the cæcum forms the reflected tube. The whole mass thus formed is termed the intussusceptum. The external tube is termed the sheath. It is most commonly thrown into numerous folds, its upper part, which can be straightened out by slight traction, thus giving rise to apparent partial reduction of the invagination. The whole mass forms a rounded sausage-like tumour. On making an incision into it through the sheath the mucous surface of the reflected tube will be brought into view in contact with that of the sheath. On further cutting through the reflected tube

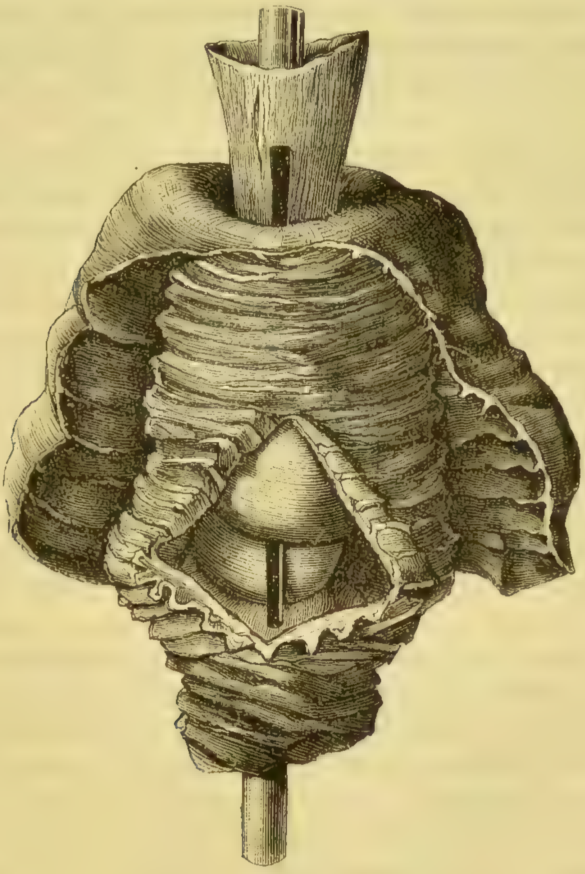


Fig. 824.—An intussusception dissected.

a space is found between the serous coats of the reflected and entering tubes containing the mesentery (Fig. 824). In very rare cases double intussusceptions, composed of five layers, or triple, with seven layers, have been observed. An intussusception increases entirely at the expense of the sheath, the line of reflection between the entering and reflected tubes remaining unchanged. The length of the part invaginated varies greatly. When limited to the small intestine it is usually short, not more than two or three inches in length ; in the large gut as many feet may be involved. The intussusceptum is more or less severely strangulated at the point of the reflection between the reflected tube and the sheath. This usually seems in part to be caused by the closely-packed folds of the sheath at the neck of the intussusception. The entering and reflected tubes are therefore intensely injected with blood, and swollen, and the mesentery included in the space between them is in a similar condition. In some exceptional cases of intussusception of the colon there is little constriction, so little, in fact, that the lumen of the gut may not be completely occluded.

There is reason to believe that in very slight cases the intussusception may undergo spontaneous reduction. In other cases, when the strangulation is not sufficiently severe to cause gangrene of the intussusceptum, though it seriously or completely obstructs the passage of fæces, death inevitably results sooner or later. If the strangulation is tight enough to cause gangrene, adhesions may form between the upper part of the entering tube and the reflection between the sheath and the reflected tube, the gangrenous intussusceptum may be cast off into the bowel and recovery take place. Unfortunately the patient usually perishes from exhaustion before this is accomplished.

The **Causes** of intussusception have given rise to much discussion, but the most reasonable view seems to be that the invagination commences as the result of irregular peristaltic action of the intestine. Nothnagel experimentally demonstrated this in the rabbit's intestine. He showed that the application of a powerful electric current to a portion of the gut caused a contraction extending a short distance below the point stimulated, and a considerable distance above it. At the same time the uncontracted bowel below rose up over the lower end of the contracted part, thus giving rise to limited intussusception. He also obtained somewhat similar results by paralysing a portion of the gut by crushing, but it is improbable that anything analogous to this occurs in the production of intussusception in the human subject. When the invagination has once commenced, the intussusceptum is passed on by the contraction of the bowel, like a mass of fæces or a foreign body. That irregular peristaltic action is the probable cause is shown by the fact that in children it is sometimes due to the irritation of worms or the straining accompanying dysenteric diarrhœa. The intussusception of the dying so commonly found in *post-mortem* examinations, is also probably the result of irregular peristaltic movements immediately preceding death. They are often multiple and occur with equal frequency in the upward and downward direction.

In adults the invagination occasionally commences at the seat of a tumour.

Symptoms.—Intussusception may run an acute, subacute, or chronic course. The variation depends upon the degree of strangulation. When this is slight, the lumen of the bowel may not be occluded, and the disease runs a chronic course. When the bowel is completely obstructed from the first, the symptoms are acute.

In the **Acute and Subacute Forms,** the invasion is usually sudden, the patient feeling that something has gone wrong internally. In an infant there is usually screaming, evidently from severe pain. The symptoms of obstruction then develop. Vomiting soon sets in, but is not very severe, and rarely becomes stercoraceous till a late period unless the intussusception is in the jejunum. The pain is griping in character and intermittent. In almost all cases there is marked tenesmus with the passage of blood and mucus from the bowel. This is one of the most important and characteristic symptoms. There is little or no distension of the abdomen, and the coils of intestine are not visible. The degree of collapse varies. In extreme cases the patient has been known to die in less than 24 hours from shock. More commonly it is not severe except in very young infants. In subacute cases the obstruction may not at first be complete, in fact there may even be some diarrhœa, but this is rare. On examination of the abdomen if necessary with the help of an anæsthetic, a tumour can usually be felt at the seat of disease. It is sausage-like in form, doughy to the feel, and becomes tense under manipulation from the peristaltic contraction of the gut composing it. It is tender, and the hardening during manipulation is accompanied by some griping pain. If the case be watched from the beginning, the tumour will be found to change its position as the invagination progresses ; thus, when beginning at the ileo-cæcal valve, it will at first be felt in the right iliac fossa, subsequently in the umbilical region, and often at last in the left iliac fossa. If the intussusception be ileo-cæcal, or of the great intestine, it often descends low enough to be felt by passing the finger into the rectum, and not unfrequently it protrudes from the anus and may thus resemble a simple prolapsus of the bowel. Such a condition is easily recognised by passing the finger beside the protruded gut into the rectum, which it is of course impossible to do in a case of prolapsus. The nature of the tumour, when it lies in the rectum, may be recognised by feeling the opening in the apex of the intussusceptum, which has been compared to the os uteri.

The **Prognosis** in acute or subacute intussusception is very bad, especially in children under one year of age, of whom not two per cent. recover if the case be left to nature. The great majority die before the seventh day from shock and exhaustion. In older patients, recovery may take place by gangrene and subsequent elimination of the invaginated bowel. This is said to occur in about 40 per cent. of all cases. The chance of its occurrence steadily increases with the age of the patient. When it is about to happen, the discharges from the bowel become offensive and finally the gangrenous gut is passed and followed by a motion. Separation of the gangrenous gut is, however, by no means always followed by recovery. According to Treves, 40 per cent. die from failure of the adhesions to prevent extravasation of fæces, from ulceration and perforation of the gut, from hæmorrhage or pyæmia. If elimination does not take place death is inevitable, unless it can be prevented by surgical interference.

Chronic Intussusception forms about 18 per cent. of all cases. It occurs far more frequently in adults than in children. In 60 per cent. the invagination occurs at the ileo-cæcal valve. The symptoms of this form are often very anomalous. The invasion is not usually very sudden, and as the lumen of the bowel is not completely occluded, nor the strangulation sufficient to cause shock or gangrene of the gut, the other signs of intussusception may be more or less wanting. The constipation is not complete; there may even be diarrhœa, or alternate constipation and diarrhœa. Vomiting is slight and intermittent, and the pain paroxysmal and colicky. Tenesmus is absent in most cases; in about half there is no blood or mucus in the stools. There is usually little distension of the abdomen; but if the cases last long enough some hypertrophy of the muscular coat of the bowel above the obstruction may take place and the coils may then be distinctly visible through the thin abdominal wall. In about half the recorded cases the characteristic tumour has been recognised. The general health suffers considerably, the appetite is bad, and the patient gradually loses flesh and strength. The duration of chronic intussusception is usually at least two or three months, and Treves mentions one case in which it extended to one year. The patient may die merely from exhaustion, or complete obstruction may set in and prove fatal. In some cases perforation of the gut above the obstruction has been the immediate cause of death. Recovery by separation of the intussusceptum is infinitely rare.

Relative Frequency of the Various Forms of Intestinal Obstruction.—Bryant has published the following statistics on this point derived from the records of Guy's Hospital, and collected chiefly by the late Hilton Fagge. The obstructions caused by disease of the rectum and by chronic peritonitis are included. The total number of cases was 124. Of these 33 were acute, 76 chronic, and 15 were due to intussusception. Of the 33 acute cases, 1 was due to internal hernia, 7 to volvulus, and 25 to strangulation by bands. Of the 25 bands, 14 were old adhesions, 6 were connected with diverticula from the ileum, 2 with the vermiform appendix, 2 with the neck of a hernial sac, and 1 with the pedicle of an ovarian tumour. Of the 76 cases of chronic obstruction, 3 resulted from fæcal impaction, 3 from pressure of tumours, 47 from stricture, and 23 from matting together of the intestinal coils from chronic peritonitis or cancer. Of the 47 strictures, 2 were in the small gut and 45 in the large. To these 45 may be added 59 collected by Morris and Coupland. Of these 104 strictures of the great intestine, 78 were in the rectum and sigmoid flexure, 19 in the tranverse colon, and 7 in the cæcum.

Diagnosis of the Cause of Obstruction is of the greatest importance, for in certain forms there is no possibility of recovery except by surgical interference, and the operation to be performed must be adapted to the nature of the case.

In the first place, it is necessary, if possible, to exclude certain conditions, which, though not generally included under the name of intestinal obstruction, give rise to symptoms of a similar nature. The most important of these are simple intestinal colic, typhlitis, perforation of the vermiform appendix, and acute general peritonitis, which simulate acute obstruction and lead colic, and chronic peritonitis which may resemble the chronic forms.

In simple intestinal colic vomiting is not a prominent symptom, and is never stercoraceous. Constipation is rarely complete, flatus, if not fæces, passing, and there is no collapse. The symptoms of perforation of the vermiform appendix will be given with the description of that disease at the end of this Chapter.

Acute General Peritonitis is characterised by the marked tenderness of the abdomen with rigidity of its walls. The vomiting is not so profuse, rarely stercoraceous, and occurs without straining or retching. The ejecta are usually dark-coloured. The constipation in peritonitis is very frequently incomplete, flatus, if not fæces, passing. In intestinal obstruction the temperature is usually subnormal, in peritonitis it is commonly elevated. The diagnosis is, however, confused by the fact that general peritonitis may occur as a complication of some forms of acute obstruction.

Lead Colic is recognized by the history of the cause, the retraction of the belly, with total absence of distension, the absence of vomiting, and the blue line on the gums.

Chronic Peritonitis is sometimes included as one of the causes of intestinal obstruction, and it no doubt does occasionally prove fatal in this way. When this happens the obstruction is due to matting together of the coils of intestine, or possibly to the formation of bands, and is rather an accident in the disease than an essential part of it. Chronic peritonitis is most commonly tubercular, but it also arises in connection with malignant growths, and sometimes without evident cause. In the tubercular form there may be ascites; more commonly there is some fulness, with irregular hardness, or a doughy feel in the abdomen. There is slight elevation of temperature in most cases. Vomiting is often altogether absent, and is never stercoraceous. Diarrhœa is more common than obstruction, but cases do occur in which constipation is the most prominent symptom. I saw a case some years ago which terminated fatally after more than six weeks' obstruction. The diagnosis is made by the peculiar feel of the abdomen, the presence of a small quantity of fluid, the gradual development of the disease, and possibly by the evidence of tubercle elsewhere. In simple and malignant chronic peritonitis, ascites is a marked symptom, and the condition is hardly likely to be confounded with intestinal obstruction. I have known of a case, however, in which obstruction was caused by a band formed in connection with a malignant growth in the peritoneum. The abdomen was opened and the bowel relieved from the band, a large quantity of ascitic fluid being let out at the same time. The patient survived about six weeks.

Other conditions may sometimes be mistaken for intestinal obstruction. Thus a case was sent into University College Hospital as intestinal obstruction which turned out to be stricture of the pylorus, the constipation being merely due to the fact that no food was passing into the intestine. In another case, uræmic vomiting was attributed to the effects of the pressure of a large renal tumour on the ascending colon. Such cases as these are usually easily distinguished by careful examination.

In all cases of acute obstruction all the apertures at which a hernia could protrude must be carefully examined as the first and most essential step in the diagnosis.

All the above conditions being excluded, and the case being recognized as one of genuine intestinal obstruction, the next question is to determine whether it is to be classed as acute or chronic. There is no difficulty in recognizing a typical case of either kind by attention to the symptoms already described (p. 870, and p. 876). Internal strangulation of all kinds, volvulus and acute intussusception are typically acute; stricture of the great intestine, fæcal accumulation, and chronic intussusception are typically chronic; obstruction from a foreign body in the small intestine, stricture of the small intestine, and some cases of intussusception, although usually presenting symptoms which would bring them into the acute class, may verge upon the chronic. In some cases of chronic obstruction of the great intestine, acute symptoms may suddenly develop from a twist of the gut above the obstruction.

The differential diagnosis of the various forms of internal strangulation and twist involving the small intestine is practically impossible, and these may be classed together. Impaction of foreign bodies, including gall-stones, volvulus of the sigmoid flexure, sudden occlusion of a stricture of the small intestine, and acute intussusception in a large proportion of cases present sufficiently definite symptoms to make an accurate diagnosis possible. Among the chronic obstructions, stricture, fæcal accumulations, and chronic intussusception, may usually be distinguished from each other, but it is often impossible to determine the exact seat of the obstruction and its nature in cases of stricture. These facts being borne in mind, it is best to write down on a sheet of paper all the conditions above mentioned, and then to examine the patient methodically in the manner about to be described, noting every symptom under the disease to which it apparently points. In this way a diagnosis will probably be made, if it be possible.

The points which will engage the Surgeon's attention are :—1. The previous history. 2. The mode of invasion. 3. The general condition. 4. The character of the pain. 5. The character of the vomiting. 6. The duration and degree of constipation. 7. The physical examination of the belly. 8. Examination of the rectum. 9. The character and quantity of the urine.

1. The **Previous History** often throws much light upon the nature of the disease. In cases of *internal strangulation*, and in intussusception, the patient has usually enjoyed good health up to the time of the obstruction, although in some cases there is a history of a previous attack of the same kind. If the other symptoms seem to point to strangulation by a band, diseases likely to cause local adhesions in the peritoneum, such as typhoid fever, typhlitis, or ovaritis in the female, may be inquired for. In *Volvulus of the Sigmoid Flexure* there is a history of habitual constipation. In cases of *obstruction of the small intestine from impaction of a gall-stone*, there will be a history of prolonged pain and discomfort in the region of the gall-bladder during the time that the stone was making its way by ulceration into the intestine. In *stricture of the small intestine suddenly occluded* there is a long history of digestive troubles, attacks of colic, especially after food, and often of previous attacks of obstruction which have passed off. In chronic obstruction arising from *gradual closure of a stricture* there is a history of gradually increasing difficulty in obtaining relief from the bowels, with uneasiness and dyspepsia. Most commonly there have been periods of prolonged constipation followed by diarrhœa. These alternating periods of constipation and diarrhœa are very characteristic, and should always raise a suspicion of stricture, most probably in the great intestine. In *Fæcal accumulation* there has been chronic constipation of long duration.

2. **Mode of Invasion.**—In *Internal strangulation* the attack commences with severe pain, coming on so suddenly that the patient can state within an hour or less the exact time at which it seized him. In *Volvulus of the sigmoid flexure* the invasion is usually sudden, but commonly less so than in internal strangulation. In *Impacted gall-stone* the attack begins with uneasiness, increasing steadily in a few hours to actual pain. In *Obstruction of a stricture of the small intestine* the invasion is much like that of impacted gall-stone. In *Acute*

intussusception the attack is usually very sudden. In all the *chronic obstructions* except intussusception the symptoms develop gradually.

3. The **General Condition of the Patient.**—In *Internal strangulation, Volvulus, and Acute intussusception,* there is usually early collapse, with a small quick pulse, and a subnormal temperature. Thirst is often a prominent symptom. In *Impacted gall-stone* and *Occluded stricture of the small gut,* collapse is not marked. In the *Chronic obstructions* there is no shock or collapse, and exhaustion comes on gradually. The tongue is foul in all forms.

4. The **Character of the Pain.**—In *Internal strangulation* it is most intense, often amounting to agony. It is usually referred to the umbilical region. In *Volvulus of the sigmoid flexure* it is less intense and paroxysmal, Later on acute tenderness is present from peritonitis. In *Impacted gall-stone* the pain is not usually severe, sometimes little more than uneasiness. In *Acute intussusception* the pain is severe and paroxysmal, often causing periodical screaming in children. In *Chronic obstruction from Stricture of the great intestine* or *fæcal accumulation* there is diffused uneasiness, and after a time paroxysms of griping pain occur. In *Chronic intussusception* there is paroxysmal griping pain.

5. The **Character of the Vomiting.**—In *Internal strangulation* the vomiting sets in at once, is very frequent and profuse, and very soon becomes stercoraceous. In *Volvulus of the great intestine* it sets in later, is seldom profuse, and most frequently does not become stercoraceous. In *Impacted gall-stone* and *Occluded stricture,* it appears early and gradually increases in frequency, but may not become stercoraceous for many days. In *Acute intussusception* vomiting is often not a very prominent symptom, and does not become fæculent for some days. In all *chronic obstructions* vomiting is long delayed, moderate in amount, and does not become fæculent until after two or three weeks. It is usually kept in check without difficulty by proper treatment and feeding.

Fæculent vomiting, though one of the most characteristic symptoms of mechanical obstruction of the intestines, is occasionally present when apparently no such condition exists, disappearing after a time under the influence of opium, and as above stated, in some varieties of actual obstruction it is altogether wanting.

6. The **Duration and Degree of Constipation.**—In *Internal strangulation* and *Impacted gall-stone* the constipation is complete, neither fæces nor flatus passing, nor, except in a few cases of volvulus, is there any sense of a desire to go to stool. In *Acute intussusception* there is marked tenesmus, and blood and mucus sometimes mixed with some fæcal matter are discharged, without which a diagnosis of intussusception cannot be made. In these cases the constipation is sudden in persons previously regular in their bowels, and there is a sense of its dependence on a fixed cause. In *Volvulus of the sigmoid flexure,* the complete arrest of flatus and fæces comes on suddenly, but there has been a previous history of chronic constipation. In *Chronic obstruction from stricture* the constipation is complete, but is gradually developed as an aggravation of previous partial obstruction. Unless the stricture be in the rectum there is rarely any tenesmus. In *Fæcal impaction* the constipation is not always complete, flatus occasionally passing. There is usually a sense of a desire to defecate. In *Chronic intussusception* constipation is the exception ;

there may be tenesmus with the passage of blood and mucus, but this is by no means constant as in the acute form.

7. The **Physical Examination of the Belly.**—(a.) **Inspection.**—The chief points to be observed are, the distension of the abdomen, the form it has assumed, the appearance of coils of distended gut and peristaltic movements.

Distension of the Abdomen.—In *Internal strangulation* it seldom develops before the third or fourth day, and is seldom extreme. In *Volvulus of the great intestine* it appears from the commencement and forms one of the most marked features of the case. It may be so great as to interfere with respiration and in this way cause death. In *Impacted gall-stone* distension is slight or wanting, and the same is the case in *Acute intussusception.*

In *Chronic obstruction from stricture* it gradually increases, and after one or two weeks may become excessive, causing much distress. In *Chronic intussusception* it is absent, unless the obstruction is complete.

The **Form of the Abdomen.**—When the obstruction is in the small intestine and acute, the distension is usually, in the early stages, most marked in the epigastric, umbilical, and hypogastric regions, the flanks being less distended. In obstructions low down in the great gut the distended colon on each side fills out the flanks, giving the abdomen a barrel-shape. In some cases of strangulation by a band of internal hernia, the abdomen may be irregularly distended, one side or region being more prominent than the rest. Too much importance must not be attached, however, to the form of the abdomen, as it is often deceptive, and especially when the distension is great. In women who have borne children, there is always great prominence in the umbilical and hypogastric region, whatever the cause of the distension may be.

Coils of Intestine visible through the abdominal walls may be observed when the patient is thin in all forms of obstruction if there is much distension. In *Internal strangulation* this symptom occurs late if at all. In *Volvulus of the sigmoid flexure* the enormous size of the distended gut does not suggest a coil of intestine. In *Impacted gall-stone* and *Acute intussusception*, no coils are visible as a rule. In *Stricture of the small intestine*, as the gut is already dilated and hypertrophied, the coils readily become visible should obstruction occur. It is in *Chronic obstruction from stricture of the great intestine*, and in chronic intussusception, that the distended coils of small intestine are usually most distinctly visible.

Peristalsis of visible coils is most marked in *Chronic obstructions in the great intestine.* It may be taken as evidence that the gut is not paralysed by acute peritonitis ; but beyond this it is of no great value.

(b.) Percussion.—By percussion we try to ascertain the condition of the colon. In the normal condition the different notes given by the stomach, colon, and small intestine, usually enable us to determine their positions, but in the distended abdomen the evidence thus obtained is often fallacious. The stomach is always concealed by the distended intestines. If the small intestines are much distended their note becomes indistinguishable from that of the colon. Extreme superficial tympanitic resonance, uniform in note and concealing the liver dulness, with a very pointed abdomen, indicates free gas in the peritoneal cavity either from actual or impending perforation. Hyper-resonance in each flank is usually a sign of a distended colon. Dulness in the flanks, disappearing on turning the patient on one side, is usually evidence of fluid, and may indicate that peritonitis is commencing. In a case in University College Hospital a few years ago, this sign was, however, found to be dependent on a loaded colon with a long meso-colon, which moved out of the flank when the patient was turned to the opposite side.

(c.) **Manipulation.**—By manipulation we estimate the degree of tension and the presence or absence of tenderness or tumour. In *Internal strangulation* it is very rarely that localised swelling or tenderness can be recognised. In *Volvulus of the sigmoid flexure* tenderness from peritonitis is an early symptom. In *Impacted gall-stone* an ill-defined hardness may occasionally be recognised, probably below and to the right of the umbilicus. In *Intussusception*, whether acute or chronic, the characteristic sausage-like tumour is usually to be found. In *Chronic obstruction from stricture of the great intestine* a tumour may be felt in exceptional cases, but much more commonly the results of manipulation are purely negative. In *Fæcal Accumulation* the mass can be felt and its putty-like consistence recognised. In all cases as soon as the distension becomes excessive, manipulation is useless. It may in the earlier stages be much facilitated by relaxing the abdominal walls by means of an anæsthetic.

8. **Examination of the Rectum** should never be omitted; by it we ascertain the presence of strictures within reach of the finger, or tumours pressing on the rectum, and of fæcal accumulations. In intussusception, we may feel the end of the invaginated intestine. Those whose hands are small enough to pass into the rectum, an uncommon condition in men, might possibly detect a malignant stricture in the sigmoid flexure.

If the stricture be seated at the upper part of the rectum, it may be recognised in some cases by a careful examination of the bowel with bougies, but this mode of examination is rarely of any value.

Another method of examination often employed is the administration of the largest possible enema, with the view of ascertaining whether the obstruction is low down in the great gut. This is very fallacious, as the abdominal distension is often so great that even when the whole colon is free, the patient cannot bear the injection of more than a few ounces of fluid.

Treves states that by careful auscultation of the abdomen during the administration of an enema, it is sometimes possible to find the point of obstruction. If the colon is free, the fluid may be heard most clearly as it enters the cæcum.

9. The **Quantity of Urine.**—It is frequently stated that in obstruction high up the quantity of urine secreted is diminished, owing to the lessened extent of intestinal surface capable of absorbing liquids. That scanty urine is commonly met with in these cases is undoubted, but it is probably due to the fact that the patient vomits all the liquid he takes.

By attention to the foregoing points, there may be no great difficulty in coming to an accurate opinion as to whether the obstruction is in the large or small intestine. It may also be borne in mind that with the exception of twists of the colon and acute intussusception, all acute obstructions are seated in the small intestine, while the great majority of chronic are in the large. Yet cases do occur in which, though the obstruction be seated in the large intestine, and due to chronic stricture, the symptoms are acute probably from twist or kinking above the narrowed part, and thus errors of diagnosis will occur in spite of every precaution the Surgeon may take to avoid them.

TREATMENT.—**Treatment of Acute Obstruction.**—This must necessarily be in a great measure determined by the diagnosis that is made as to its cause. The treatment of intussusception presents so many special points, that it will be better to consider it separately. If the obscurity of the symptoms renders an exact diagnosis in the early stages almost impossible, it is generally expedient to try the effect of proper medical treatment, which will sometimes, even in apparently hopeless cases, afford relief. In former times it was the custom to administer purgatives in these cases, but it has long been recognized that they do nothing but harm; they increase the pain and vomiting, exhaust the patient, and can have no influence over any real intestinal obstruction. The only plan that appears to me of any value is the continued administration of opium. The opium may be given in the solid form; but in acute obstruction, if there is much vomiting, this would be useless, and hypodermic injections of morphia should then be administered. It must be given in such quantities as to relieve pain; usually about one grain of opium, by the mouth, or a quarter of a grain of morphia hypodermically every six to eight hours will be found sufficient. This treatment will in all cases be of considerable service, and in some, even the most hopeless and complicated, will afford satisfactory results. In a very complicated case of intestinal obstruction which I attended with Garrod, this plan was eminently successful. A patient was admitted into the hospital, having symptoms of internal strangulation; he had at the same time double inguinal hernia, and a small umbilical rupture, as well as the remains of a fatty tumour, which had been partially removed from the abdominal wall many years previously. There were peritonitis with tympanites, stercoraceous vomiting, and much vital depression; but, as there was no strangulation existing in any of the external herniæ, and as there was no evidence as to the precise locality of the internal mischief, it was not thought advisable to have recourse to operation. The patient was accordingly treated with opium, when, on the tenth day, the obstruction gave way and the bowels acted, the patient ultimately recovering. In some cases the pain is relieved by the application of hot fomentations, but these have no curative effect.

H. O. Thomas of Liverpool, who has paid considerable attention to the subject of intestinal obstruction and advocates the exclusive use of opium in all forms of the affection, gives some valuable practical directions for the management of these cases. He insists that the drug must always be administered hypodermically, and in sufficient quantity to relieve all pain. The patient must of course be confined to the recumbent position. His diet must be limited to the smallest possible amount and must be exclusively liquid. Arrowroot or ground rice cooked with water, with the addition of a little brandy or wine, is the food he chiefly recommends; mutton or chicken broth being occasionally allowed as a change. Milk he has usually found to aggravate the symptoms. On small quantities of this food, given at intervals of two hours, a patient kept warm in bed and under the influence of opium may maintain life for many weeks without serious loss of strength. Should natural relief take place, the restricted diet and rest should be continued till all pain has passed away and the bowels have become regular. In cases of acute obstruction with severe vomiting, Thomas states that the patient experiences much relief from having the foot of the bed raised about ten inches on blocks, by which the act of vomiting is facilitated. He advises that the abdomen should be kept cool. If symptoms of collapse appear, he recommends the hypodermic injection of small doses of atropine.

The external application of belladonna has been recommended with the view of stimulating the peristaltic action of the intestine, but it does not seem to have been of any service.

Enemata, administered by means of a long tube, are very commonly employed, but they are perfectly useless in all acute obstructions except intussusception, and aggravate the patient's sufferings. In chronic obstruction from stricture low down in the great intestine, they may be of service. If the obstruction be within reach from the anus a gum elastic catheter can sometimes be passed through it by which an olive oil enema may be thrown up above the stricture, after which the motion may pass. In fæcal accumulation large olive oil enemata are often of service.

The application of **Ice** to the abdomen and its administration by the mouth conjoined with cold enemata; the application of **electricity** and **massage** of the abdomen have all been recommended and adopted in cases of intestinal obstruction, with the intention of stimulating the peristaltic action of the intestines, but it is evident that these methods can be productive of nothing but harm in cases of genuine mechanical obstruction. They aggravate the pain, increase the vomiting, and hasten death from exhaustion. If the obstruction were due to fæcal accumulation from partial paralysis of the muscular coat they might be of some use.

The administration of **metallic mercury** in large quantities, with the view of overcoming the obstruction by its weight is an ancient and barbarous treatment which cannot be of any use in genuine obstruction.

To sum up therefore, unless the Surgeon determine to adopt operative treatment of some kind, the only justifiable treatment is the administration of opium conjoined with proper feeding. It is, however, evident that in a large number of cases there is no hope of relief without operative interference.

Inversion of the Patient is an ancient mode of treatment, which is perhaps too much neglected in the present day. It is perfectly free from danger, and if it does no good does no harm. It is applicable only to those cases in which the sudden invasion of the disease and the acuteness of the symptoms lead to a strong presumption of strangulation by a band or internal hernia. It is useless to attempt it if there is great abdominal distension. The operation is done as follows. The patient is anæsthetized to complete muscular relaxation. He is then suspended by the flexed knees over the shoulders of a strong man. The small intestines will then be seen to gravitate towards the epigastrium, the pubic and iliac regions becoming hollow. The abdomen may now be gently manipulated, and the man who supports the patient may raise himself on his toes and come down sharply on his heels so as to give a slight concussion. In a case at University College Hospital, of extremely acute obstruction with violent stercoraceous vomiting, this treatment was immediately successful. As the patient was inverted there was a loud gurgle and a feeling like the reduction of a large hernia was perceived by the hand on the abdomen. I have seen a case of fatal obturator hernia—unrecognised during life—in which at the *post-mortem* examination it seemed probable that inversion and shaking would have effected reduction and so saved the patient.

Puncture of the Intestine by means of a trochar or the aspirator for the purpose of withdrawing flatus in cases of great distension has been frequently performed, sometimes with great relief to the patient. It may be safely done with a trochar about a tenth or a twelfth of an inch in diameter.

This must be introduced at the most prominent resonant point. The trochar is then withdrawn and the cannula left in for from five to ten minutes, the gas being allowed to blow off. It must not be moved about needlessly while it is in the gut. When no more gas escapes, the vacuum of the aspirator may be applied to it as it is withdrawn to prevent any fæcal matter falling into the peritoneal cavity. If the cannula becomes choked with fæcal matter it should be withdrawn. The puncture is rarely followed by any escape of fæces into the cavity of the abdomen. In some apparently hopeless cases relief of the obstruction has been known to follow the paracentesis of the intestine. These have probably been instances of kinking or partial twist above a stricture of the great intestine.

Operation for Acute Intestinal Obstruction.—When a patient is suffering from the symptoms of internal strangulation which resist medical treatment, and have not yielded to inversion—if it have been thought expedient to employ it—he will to a certainty die, unless relief can be afforded by operation ; and two great questions will at last press themselves upon the Surgeon's attention : - 1, whether it is advisable to have recourse to operative interference ; and, 2, when it is proper to undertake it. The mere opening of the abdomen with proper antiseptic precautions is not regarded in the present day as a serious proceeding, and may be undertaken with little hesitation if the symptoms are such as clearly to indicate mechanical obstruction of the small intestine. The fact that apparently desperate cases occasionally recover under the treatment by opium, should not cause the Surgeon to hesitate if the symptoms are such as to justify the diagnosis of internal strangulation or twist. The chances of success are much greater if the operation be performed early before inflammatory changes have occurred in the strangulated bowel and the rest of the intestines have become distended with gas. The conditions unfavourable to the operation are marked collapse and great distension of the intestines. The operation will be described on a subsequent page.

Enterotomy consists in opening the abdomen, by preference in the right iliac region, seizing the first piece of distended gut that appears, attaching it to the wound and opening it. It has found but little favour in this country and is rarely performed except as a last resource after laparotomy. Thus if on opening the abdomen the cause of obstruction was found to be a stricture of the small intestine with matting together of the neighbouring coils, enterotomy would give the only chance of prolonging the patient's life.

Treatment of Chronic Intestinal Obstruction.—As before stated, this arises most commonly from one of the following causes : fæcal impaction, compression of the great intestine by a tumour and stricture of the large intestine.

Fæcal impaction is most common in elderly women. When it is suspected, the rectum should be explored, and if it be found to be blocked up by a rounded mass of indurated and impacted fæces, the Surgeon must condescend to undertake the duties of the nightman, and empty the human cloaca of its fetid accumulations. This is best done by anæsthetizing the patient, then dilating the sphincter ani with the hand, breaking down the indurated mass with a spoon or lithotomy scoop, and washing it away by copious enemata.

If the obstruction arise from the gradual compression of the rectum by an *intrapelvic tumour*, or from *malignant* or simple stricture of the great intestine, purgatives will be worse than useless ; they will irritate, will often induce vomiting, and will always considerably increase the patient's distress, and should not be repeated. The patient should be kept quiet in bed, and have a limited supply of food ; such as leaves little residue is preferable, the best being beef-tea, with arrowroot and a small quantity of brandy. Milk and soda-water is sometimes taken easily, but very often milk in any form and eggs are not easily digested. Enemata may be fairly tried, but if they do not soon overcome the obstruction nothing is gained by persistently annoying the patient with them. In some cases the introduction of the tube of a stomach pump as far as possible, and the administration of an injection in this way may bring about relief. If the stricture is within reach, a catheter can sometimes be introduced through it, by means of which a large olive oil enema may be administered, and in this way the obstruction may be overcome. If these means do not succeed, opium may be administered, and sometimes after some weeks, the obstruction may give way. Thomas states this has frequently occurred in his practice, and that he has been able to prevent the early return of the obstruction by keeping the patient on the restricted diet already mentioned.

When other means have failed and the patient is becoming exhausted, operative interference becomes necessary. When, as is most frequently the case, the disease is seated in or below the sigmoid flexure, the descending colon may be opened ; but should there be any reason to believe that the obstruction is situated at a higher point the operation must be performed on the right side.

Treatment of Intussusception.—There can be little doubt that spontaneous reduction occurs in many of the slighter cases of intussusception, but when the disease is fully developed the only possible mode of natural cure is by gangrene of the intussusception and its subsequent separation and expulsion. This mode of cure does not occur in more than a quarter of all cases. In children under 10 years of age, in whom 50 per cent. of all cases occur, recovery by separation of the intussusception is very rare, certainly not happening once in twenty cases. Under two years of age it occurs in less than 2 per cent. In these cases therefore, unless the invagination be reduced by mechanical means death is almost inevitable.

In all cases, as soon as the diagnosis is made, small doses of opium should be given to arrest peristaltic movement and thus to prevent the increase of the invagination. **Inflation of the Bowel** should then be tried without delay. In order to do this the patient must be put fully under the influence of chloroform to prevent straining and to relax spasm in the bowel. The nozzle of a common Higginson's enema syringe is then inserted into the anus which is caulked round the tube with wet wool. Air or water, or a mixture of the two, is then injected into the bowel, care being taken not to use too much force or to carry the distension too far, as serious injury to the intestine has been known to result. At the same time the tumour should be grasped if possible through the relaxed abdominal walls and gently manipulated, as this seems in some cases to aid in reduction. In a case recently in University College Hospital reduction was in fact effected by manipulation alone through the thin abdominal walls of a young child. As the inflation proceeds the tumour will be felt gradually to move in the direction of the cæcum, and a last to disappear, leaving perhaps a sense of fulness behind it due to the swollen state of the gut. Inflation has been successful in a large number of recorded cases, especially in infants. It can evidently be of use only in the ileo-cæcal and colic varieties. In a case under my care in a child aged ten years, the patient not being anæsthetized felt "as if a bone broke" in the abdomen as the reduction took place. If inflation fails after a proper trial, little will be gained by repeating it. The patient must then be left to the chance of spontaneous cure under the influence of opium, or laparotomy must be performed and an attempt made to reduce the invagination. This operation was first suggested by Nuck, and has been successfully performed by Hutchinson, Howard Marsh, Godlee and others in this country. Treves has tabulated 33 cases. Eighteen were under 2 years of age, and of these 4 recovered ; 4 were between 2 and 15, and all died ; 11 were above 15, and 5 recovered. In 10 of the cases reduction was easy, and of these 7 recovered ; in 23 it was difficult or impossible, and of these all died but 2. If the gut cannot be reduced the Surgeon has the choice between replacing it, closing the wound and leaving the patient to the chance of spontaneous cure, or of resecting the invagination, treating it like gangrenous gut in strangulated hernia. If this be done it is better to make an artificial anus, which can be closed by a subsequent operation if the patient survives. The choice between these two methods will depend on the state of the gut, the presence or absence of adhesions at the neck of the intussusception and the general condition of the patient.

Further experience is required to determine the conditions favourable to the operation. Severe symptoms with much tenesmus and little or no blood indicating arrest of circulation in the intussusception show that reduction would probably be difficult or impossible. In children under two, if insufflation fails laparotomy gives practically the only chance of life.

In chronic intussusception insufflation is seldom of much use and laparotomy gives the best chance of life. The operation has been successfully performed by H. G. Howse.

OPERATIONS FOR INTESTINAL OBSTRUCTION.—**Laparotomy**, or, as it was formerly incorrectly termed, *Gastrotomy*, may be required for :—1. Internal strangulation of all kinds ; 2. Volvulus of the small intestine ; 3. Impaction of a foreign body, or gall-stone ; 4. Intussusception, acute or chronic.

In performing the operation of laparotomy, all the rules already laid down for abdominal operations in general must be attended to (p. 793). The patient must be laid on a high table, the legs being allowed to hang over the end of it so as to afford a full view of the abdomen. The anæsthetic having been administered, and the bladder emptied, the incision should be made below the umbilicus in the middle line. If the patient be very fat it may be necessary to enlarge the wound upwards. Even in cases such as intussusception, in which the tumour is situated on one side of the middle line, the median incision will always be found the best. It is accompanied by less hæmorrhage, and leaves less tendency to the occurrence of ventral hernia. The linea alba then having been exposed, the incision must be carried through the abdominal wall until the peritoneum is reached. All hæmorrhage must then be carefully arrested, after which the peritoneum may be carefully opened and divided to the extent of the wound on a director. The incision should at first be only just large enough to admit the hand, which may be introduced without allowing the intestines to escape. It should at once be passed to the region of the cæcum. If this can be felt collapsed it proves that the obstruction is in the small intestine. At the same time a tumour or intussusception at the ileo-cæcal valve might be felt. If the case is one of obstruction from gall-stone, it will commonly be felt in the lower part of the ileum while passing the hand towards the cæcum. A constricting band may possibly be felt in the same way. If the cæcum be found to be distended, the hand should, if possible, be carried along the great intestine till the obstruction is found. If the case is one of obstruction of the small intestine, the Surgeon should try to find the collapsed gut below the obstruction, and draw a coil of it out at the wound. This is not easy to do, as the distended coils conceal the collapsed gut, and tend to protrude at the wound. They should be kept under control as much as possible by the pressure of a large flat sponge, or, if they protrude, they may be covered with a linen cloth soaked in warm carbolic lotion (1 in 40). By following along the intestine, reducing one part as the next is withdrawn, the obstruction may at last be reached. It will usually be found that however careful the Surgeon may be, if there is much distension, a large part of the intestine will be exposed before the obstruction is found. If there be a hernial constriction formed by a dense adventitious fibroid band, he may divide the band that constitutes the stricture on a director by means of a probe-pointed bistoury or hernia knife, or break it through with the finger; or he may withdraw the constricted coil of intestine from an aperture in the omentum or mesentery into which it had slipped. If it be a case of volvulus, the gut may be untwisted, as in a case on which I operated in 1849.

If the case turns out to be a *volvulus of the sigmoid flexure*, it may be reduced, after puncturing it to let out the gas; but experience has shown that the twist returns as soon as the flatus re-accumulates. The only hope of cure lies in colotomy.

If a *gall-stone* be found, an attempt may be made to push it on into the great intestine, as has been successfully done in one case by Clutton. Failing this, it has been suggested to break up the stone with a fine needle passed through the wall of the gut, but this plan has not yet been actually practised. Lastly, the stone may be cut out by a longitudinal incision in the gut. This operation was first performed by Walters, of Reigate, the case unfortunately ending fatally. It has since been successfully accomplished by T. Smith. The incision in the gut should be closed by sutures in the ordinary way.

If the case turns out to be one of *stricture of the small intestine* little can be done beyond the formation of an artificial anus above the obstruction.

If the case be one of *intussusception* it is generally useless to attempt to reduce the invagination without bringing the whole tumour out upon the abdominal wall. This can usually be done without difficulty, and as the distension in these cases is seldom great it may be accomplished without allowing the small intestines to escape. Reduction must be accomplished by a process of kneading and drawing down the sheath, rather than by forcibly attempting to drag out the entering tube. If reduction is impossible, the Surgeon has three courses open to him. He may return the bowel and leave the patient to his chance of a natural cure; he may bring out the piece of intestine and make an artificial anus in the wound; or he may cut off the whole invaginated part and sew the two ends of the gut to each other. The course to be adopted will depend on circumstances. As it is presumed that the operation has been undertaken because there was no hope of a spontaneous cure, the first course is not likely to be successful, though in many cases it is the only one that can be adopted owing to the exhausted state of the patient. The second will leave the patient an artificial anus in the most inconvenient position. The third is accompanied by great danger if done during obstruction, and it is generally recognized that the best treatment is to remove the invaginated bowel, to make an artificial anus, and to cure that by a subsequent operation. This plan would, therefore, be the best to adopt if the condition of the patient is such as to allow the necessary time for its performance. The chances of recovery are, however, not great, whichever plan be adopted.

After the obstruction, whatever may be its nature, is removed, the intestines must be returned and the wound closed and dressed as described on p. 793. If there is great difficulty in returning the distended intestines, they may be punctured with a fine hollow needle to let out the gas. The abdomen must be well supported by a bandage and the knees must be bent over a pillow. Opium must be continuously administered, and nothing but ice and barley-water allowed for from twenty-four to forty-eight hours. The mortality following laparotomy for the relief of intestinal obstruction is very high. Treves gives a table of 122 cases of laparotomy for intestinal obstruction, excluding intussusception, with a mortality of 63·1 per cent., but, as he points out, it is probable that the death-rate is much higher than this, as cases are only published either when successful, or when presenting some point of pathological interest.

Colotomy.—The operation required to give exit to the intestinal contents, is of two kinds. In one the intestine is opened in the left iliac fossa, by cutting through the peritoneum covering it. In the other it is opened in the loin by cutting between the layers of the meso-colon, being thus exposed where it is uncovered by peritoneum.

Colotomy may be required for the following conditions :—

1. Intestinal obstruction below the descending colon.
2. Volvulus of the sigmoid flexure.
3. Intense pain in defæcation, in ulcerated cancer of the large intestine or rectum.
4. Cancerous fistula between the rectum and bladder.
5. Congenital absence of the rectum.

Littre's Operation. Inguinal Colotomy.—The first operation, or Littre's, as it has been called, was proposed by a Surgeon of that name, in 1710, who advised that in these cases the sigmoid flexure of the colon should be opened from the left iliac region ; but it was not until the year 1776 that any operation of the kind was performed, when Pillore, a Surgeon of Rouen, was the first to make an artificial anus on the adult, for relief of retention of fæces : this he did, not according to Littre's method, but by opening the cæcum from the right iliac region. Fine, of Geneva, in 1797, opened the transverse colon from the umbilical region, in a case of retention of fæces produced by "scirrhus" of the upper part of the rectum.

Littre's operation is thus performed. An incision is commenced at the level of the left anterior superior iliac spine and carried downwards and inwards, nearly parallel to Poupart's ligament for from two and a half to three inches. The muscles and transversalis fascia are then divided in the same way as in the operation for ligature of the external iliac artery. The peritoneum is then opened and the distended sigmoid flexure usually at once presents in the wound. It is then drawn out and secured by a sufficient number of stitches. These should be made to include the peritoneum and skin in the abdominal wall, but should miss the muscles. If the case is not urgent the stitches may be made to penetrate the muscular and serous coat only, and the gut left unopened till the third or fourth day. If it is necessary to open the gut at once, the sutures may penetrate the whole thickness of the gut. On opening the peritoneum a piece of small intestine may present instead of the colon; this is recognized by the absence of bands and appendices epiploicæ, and by the fact that if its mesentery be gently pulled it will be felt to be fixed towards the right while the colon is fixed to the left.

Amussat's Operation, or Lumbar Colotomy.—In order to avoid wounding the peritoneum, Callisen, of Copenhagen, in 1796 proposed opening the colon from behind, in the left lumbar region, where it is not covered by peritoneum. He once attempted this operation on the dead body of a child; but, failing to reach the intestine without wounding the serous membrane, he seems to have relinquished all further idea of it. The operation was, however, subsequently practised and perfected by Amussat. It affords an admirable illustration of the important practical application of an apparently trivial anatomical fact, viz., the relation of the layers of the meso-colon to the descending colon.

Amussat, when he was attending the celebrated Broussais for cancer of the rectum, of which he ultimately died, was led to reflect on the resources that Surgery offers in similar cases; and after making some experiments on the dead body, he became convinced that the operation proposed by Callisen, if somewhat modified, was not only practicable, but safe. He soon had an opportunity of putting this opinion to the test of actual practice in 1839, in a private case, at which he kindly invited me, then a student in Paris, to be present. The operation was perfectly successful.

The following is the best method of performing Lumbar Colotomy. If the operation is to be performed in the ordinary situation on the left side, the patient must be placed on his right side, with a firm folded pillow beneath the flank, so that the body may be slightly curved to the right, and the space between the last rib and the crest of the ilium on the left side made as wide as possible. The Surgeon then measures from the anterior superior to the posterior superior spine of the ilium, carrying the tape straight from one to the other, and not along the crest of the ilium. From the mid-point between the two spines (Heath), or half an inch behind it (Allingham), a vertical line is drawn upwards, as in Fig. 825. This corresponds tolerably accurately to the line of the colon. In this line a point is taken exactly mid-way between the last rib and the crest of the ilium. An incision, either transverse or inclined slightly downwards and forwards (Fig. 825), is then made, passing through this point. It must be from three to four inches in length, half on each side of the vertical line. If the measurements have been correctly taken, the posterior extremity of the incision will be at the edge of the erector spinæ. In fact, the edge of this muscle is practically a better guide than the vertical line just mentioned. The incision is steadily deepened through the skin and superficial fascia by light strokes of the knife. After these are divided, the external oblique comes into view in the anterior two-thirds of the wound, and the latissimus dorsi in the posterior third; these are divided by drawing the knife lightly along the wound, and the internal oblique is then exposed and cut through in the same way. The fascia lumborum now comes into view. This is the first important rallying point. It must be picked up carefully with the dissecting forceps, and opened with the knife held horizontally; the finger, guiding a probe-pointed bistoury, may then be introduced through the opening, and the fascia lumborum divided freely to the whole length of the wound. At this stage the last dorsal nerve and the artery accompanying it are usually divided, and the vessel must be twisted or tied. The incision through the fascia lumborum always opens the sheath of the quadratus lumborum, the external border of which must be freely notched if it obstruct the wound. In dividing the muscles two points must be attended to: first, that these structures are cut through to the same extent as the skin, otherwise the Surgeon will continue to dig in a deep and conical pit, and will fail to recognize the gut at the bottom of it; and secondly, to avoid drifting downwards towards the crest of the ilium, as the incision is deepened from drawing the wound to one side with the left hand.

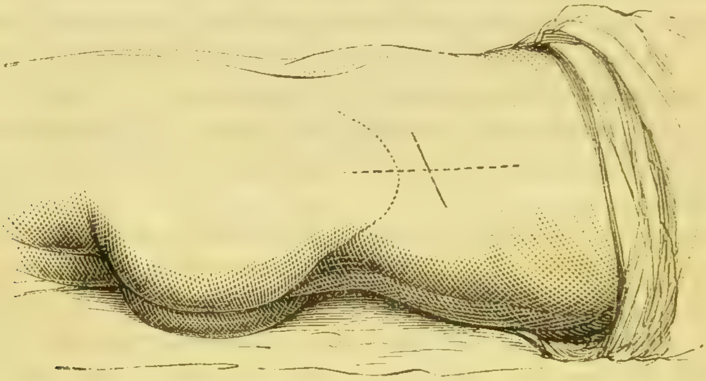


Fig. 825.—Line of Incision for Lumbar Colotomy. Dotted line indicates situation of Descending Colon.

At this stage of the operation two copper spatulæ must be put into the wound, by which it is drawn widely open. Some loose fat then comes into view, which must be carefully torn through with the fingers, no forceps or other instrument being used. In thin patients this fat is wanting. The fascia transversalis next appears. This is a very variable structure; in fat females it is scarcely recognizable, while in a thin male it is often so strong as to be mistaken for the peritoneum or the gut. It must be carefully torn through at the posterior part of the wound. The sub-peritoneal fat is then exposed, varying in amount with the fatness of the patient, and must be torn through carefully with the fingers. The gut is now reached. If the operation is being performed for obstruction, the colon is tensely distended, of a greenish colour, and usually rises up into the wound. In cases in which this operation is being undertaken for relief of pain in cancer of the rectum, the gut may be collapsed. In this state, not only is it very troublesome to find, but the part uncovered by peritoneum is so small that it is difficult to make an opening without wounding that membrane. All these difficulties are at once overcome by distending the gut with air. Lund has invented an ingenious apparatus for this purpose, but the gut can easily be distended by means of an ordinary enema-syringe, the anus being closed around the tube by a mass of wet or oiled wool pressed against it by the hand of an assistant. As the air enters the gut will be seen and felt rising up in the wound

(Fig. 826); and in most cases, if the transversalis fascia have been sufficiently torn through, it will rise up to the level of the skin. If from any reason this fails, the gut may be found by pushing the fore-finger into the wound till the lower end of the kidney is felt, immediately in front of which the colon lies. Pressure on the abdomen will sometimes make it appear. In other cases it may be found by turning the patient on his back, passing the fore-finger into the posterior part of the wound, and then seizing between it and the thumb the parts in contact with it. The patient is then rolled back on to his side and the gut drawn up into the wound. In whatever way the gut is seized, it must be drawn well up to the level of the skin. Two silk threads, each about two feet long, are then passed through the gut and the skin and fat on each side of the wound in the following way. A curved needle is threaded on the suture; it is first passed through the skin and fat on one side of the wound, then longitudinally through the anterior part of the gut exposed, including about one inch of it; finally the needle is passed from the wound through the skin and fat opposite to the point at which it entered on the other side. A similar thread is then passed in the same way, including the posterior part of the gut exposed. Care must be taken not to puncture the peritoneum with the anterior thread. An incision is then made into the gut between the two sutures, the finger introduced, the loops pulled out and divided and tied. Thus the gut is rapidly secured by four sutures immediately after being opened, and fæcal matter is prevented from running into the wound (Fig. 827). More sutures may be put in afterwards if necessary. If much escape of fæces is expected, the wound may be touched with chloride of zinc (gr. 40 to ℥j) and well dusted with iodoform, and the posterior part over which the fæcal matter will flow may be smeared with iodo-vaseline ointment or carbolic oil before the gut is opened. The gut should be brought as far back in the wound as can conveniently be done. After the operation the anterior part of the wound may be closed with sutures, but the posterior should be left partly open, and, if necessary, a drainage-tube introduced to prevent any burrowing of pus in the loose subperitoneal areolar tissue. A pad of carded oakum, or some other absorbent antiseptic material, is then applied and changed frequently. A piece of lint soaked in carbolic oil (1 in 10) may be applied next the skin, a hole being cut through it opposite the gut.

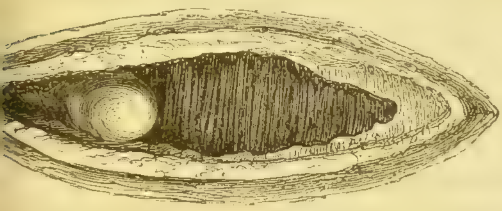


Fig. 826.—Incision in Left Lumbar Region in Amussat's Operation.

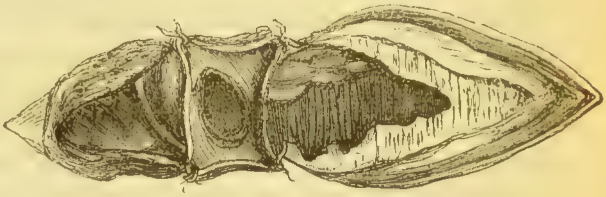


Fig. 827.—Colon opened and Stitched to Sides of Incision.

When, as in operations for relief of pain in cancer of the rectum, it is not immediately necessary to open the bowel, it may be drawn well out of the wound till a distinct knuckle of considerable size protrudes and secured to the skin in this position by a number of stitches passed if possible so as not to include the mucous membrane. It may then be dressed antiseptically and opened on the fourth or fifth day. In this way the greater part of the wound can be got to heal by the first intention.

Wound of the Peritoneum is the most serious accident during the operation, as it may be followed by peritonitis, but is by no means necessarily so. It may occur in three stages of the operation :—1, while dividing the fascia lumborum, from too free use of the knife ; 2, the posterior reflection may be torn with the finger by using it as a hook to drag the gut up into the wound ; 3, it may be punctured by the needles, or wounded by the knife in opening the gut. In rare cases free gas is met with in the peritoneal cavity, and this may lead to the peritoneum being mistaken for the gut. In some cases a complete meso-colon is met with, so that it is impossible to open the gut without wounding the serous membrane. In fat subjects the depth of the wound increases the difficulty of the operation, in some cases necessitating a crucial incision to give more space. Different Surgeons have variously modified the operation by making the incision vertical or semilunar instead of transverse, but the method above described is that usually preferred.

The patient will derive much comfort after the operation from taking powdered charcoal. It not only deodorizes, but also tends to harden, the fæces. When recovery has taken place, the aperture in the lumbar region may be kept supported and closed by means of a truss with a large pad.

After recovery two complications are not uncommonly met with, contraction of the artificial anus and prolapsus of the gut. The first is best prevented by drawing the gut well up in the wound at the time of the operation. If there is a tendency to contraction it may be prevented by introducing a conical vulcanite plug, which must be constantly worn. Prolapsus is best prevented by a properly constructed pad, secured by an elastic belt.

The causes of death after colotomy are usually exhaustion, septicæmia, peritonitis from wound of the membrane, and occasionally secondary peritonitis from burrowing of pus in the subperitoneal fat towards the iliac fossa.

Colotomy on the right side is done in the same way as on the left and presents no difference requiring notice.

Comparison of Littre's and Amussat's Operations.—When we compare the different operations that have been proposed for the formation of an artificial anus, it will be seen that Callisen's, as modified by Amussat, presents the great advantage of not implicating the peritoneum, and the risk of peritonitis is thus avoided. The danger of death from this cause in Littre's operation does not seem, however, to be so great as might have been supposed, and its advocates claim for it the advantages of being a less severe operation and of placing the new anus in a more convenient situation, as the patient is able to cleanse it himself. Also, when the operation is performed for congenital absence of the rectum, Littre's is preferable, as being much less difficult and more certain to reach the gut, which is often in infants attached by a long meso-colon in the left loin. It is said also that the risk of peritonitis in Littre's method is less than when the peritoneum is accidentally wounded in Amussat's operation, as the uniform pressure of the anterior abdominal wall tends to prevent the entrance of fæcal matter into the cavity. The fact that the sigmoid flexure is so often the seat of the disease in malignant stricture is, on the other hand, a very strong argument in favour of Amussat's operation in all such cases.

Van Erckelens has collected 262 cases of colotomy. Of these, 165 were performed by Amussat's method, and of these 63 died, about 38 per cent. ; 84 were performed by Littre's method, and of these 39 died, or about

46 per cent. In the remaining cases the method of operating was not recorded. Of the 262 cases, 110 were for cancer, 49 for strictures, 44 for imperforate anus, 43 for intestinal obstruction, and 16 for fistulous openings from the rectum into neighbouring passages. The difference in the mortality is therefore not great, but yet is distinctly in favour of Amussat's operation. Of those cases in which death has resulted from Amussat's operation, a large proportion appear to have been due, not directly to the operation, but to the influence of the previous disease, the operation having occasionally been uselessly done at the last extremity. We should, therefore, have less hesitation in performing the extra-peritoneal operation in an early stage of those cases in which it is called for, than we should if the section itself were attended with any serious risk to the patient's life.

PERITYPHLITIC ABSCESS. PERFORATION OF THE VERMIFORM APPENDIX.

Localised collections of pus form in connection with the cæcum or its appendix, either within or without the peritoneum. The extra-peritoneal form arises in connection with the cæcum or possibly from disease of the root of the appendix; the intra-peritoneal variety always arises from disease of the appendix.

Extra-peritoneal Perityphlitic Abscess is situated in the loose areolar tissue behind the cæcum, between the bowel and the fascia iliaca. It extends readily upwards towards the kidney, inwards towards the brim of the pelvis, and forwards towards the iliac spine and Poupart's ligament; but it is shut off from the thigh by the attachment of the fascia to the ligament. The abscess tends to point above and towards the outer end of Poupart's ligament.

Causes.—Perityphlitic abscess arises as a consequence of inflammation and ulceration of the cæcum. It may occur with or without perforation of the gut. In the former case there is a history of attacks of typhlitis, probably frequently repeated. For a detailed account of this disease I must refer the reader to works on Medicine. It will suffice here to mention that it is characterised by acute pain and tenderness in the region of the cæcum, often accompanied with some swelling. The bowels are confined, and there may be some sickness. There is usually some elevation of temperature about the third or fourth day. After an attack of this kind the pain and tenderness and febrile disturbance may not subside, and after a week or more distinct fixed hardness and fulness may be felt in the right iliac fossa. The swelling may slowly increase, until fluctuation becomes perceptible above the outer end of Poupart's ligament. The abscess may burst into the cæcum, and, if this occurs, recovery may take place. On the other hand, gas and fæces may escape into the cavity of the abscess, and cause its rapid increase, with severe septic fever. In other cases the abscess from the first communicates with the gut, being dependent upon perforation of the cæcum from tubercular, dysenteric, stercoral, or malignant ulceration. The **Diagnosis** of a perityphlitic abscess is made by the history, by its situation, and, if perforation occurs, by its becoming tympanitic. An ordinary iliac abscess from disease of the bone lies beneath the fascia, and readily extends to the thigh. A perinephritic abscess scarcely ever occurs without pus in the urine. The **Treatment** consists in early opening. If a perforation of the gut has taken place an artificial anus will form, which from its situation is beyond surgical interference.

Perforation of the Vermiform Appendix.—Intra-peritoneal Peri-

typhlitic Abscess.—Perforation of the appendix is most commonly caused by the presence of a solid mass blocking its lumen. Most commonly these concretions are composed largely of phosphate of lime; occasionally they have been merely hardened fæces, and foreign bodies, such as cherry-stones, have been frequently found. It may also arise from tubercular, and it is said from typhoid, ulceration. Perforation most commonly occurs in males under twenty.

The **Symptoms** are usually sufficiently definite. There is sometimes a history of repeated attacks of "typhlitis," from which the patient has recovered. In fact, it is an open question whether a large proportion of the cases of typhlitis formerly regarded as arising from the cæcum itself are not in reality due to inflammation of the appendix. In other cases the patient may have been in good health till the moment of perforation. This may occur during a violent effort, or without any evident cause. The patient complains of acute sudden pain in the right iliac fossa. This is soon followed by nausea and vomiting. Constipation soon sets in, but at first is not, as a rule, complete. It often happens that the patient has given himself a purgative after the invasion, and the bowels have responded to it. After the invasion the case may follow one of two courses. Slowly spreading, diffuse peritonitis may set in, or the mischief may remain localised for some time in the region of the appendix. In the former case the symptoms of peritonitis gradually manifest themselves. The abdomen becomes tense and tender, there is vomiting of bilious fluids, the temperature is elevated, emaciation and exhaustion rapidly take place. It differs from perforation of any other part of the intestine in the want of early collapse and in the comparatively slow progress. This is due to the fact that no fæcal extravasation occurs, as the appendix is almost invariably blocked below the point at which perforation has occurred.

When the mischief remains localised there is some fulness, with pain and tenderness in the right iliac fossa. The pain is colicky, and is sometimes referred to a distant part of the abdomen. There is usually constipation, but diarrhœa is occasionally met with. Vomiting is commonly present. After a day or two the swelling may become more evident. It is usually higher up and more internal than in extra-peritoneal abscess. The temperature is distinctly elevated, and rigor may occur. If unrelieved by treatment the almost inevitable termination is the development of general peritonitis and death, usually during the second week. In a few rare cases it is possible that the pus may burst into the bowel and recovery take place. After death the coils of intestine throughout the abdomen are found to be glued together by firm yellowish lymph. There is, as a rule, but little fluid in the cavity, probably only a few ounces in the pelvis.

The **Diagnosis** of this condition is in some cases easily made, the sudden invasion, the seat of the pain and swelling, the vomiting and the age of the patient pointing clearly to the nature of the case. From internal strangulation it is distinguished by the fact that the signs of peritonitis occur very early and precede the complete obstruction, whereas the reverse is the case in mechanical obstructions. The most difficult point is to determine whether the patient is merely suffering from an attack of typhlitis, which will soon disappear under proper medical treatment, or from actual perforation. The appearance of signs of peritonitis very early, and the severity of the symptoms, are the chief points indicating actual perforation.

Treatment.—If actual perforation has occurred the chance of recovery is certainly very small if the patient be left to nature. Unfortunately, also, if general peritonitis has set in, the chance of relief by surgical treatment is not much greater, as, owing to the firmness of the lymph glueing the coils of intestine together, it is practically impossible to clean the peritoneal cavity. The best hope of success is in the localised intra-peritoneal abscess. If this can be diagnosed and cut down upon before general peritonitis has set in the prospect of recovery is fairly good. In operating for perforation of the vermiform appendix the object of the Surgeon is to expose the diseased appendix, to let out any pus that may have formed round it, to clean the peritoneum, and to remove the diseased appendix after applying a ligature to it. In the cases in which this operation has been performed in University College Hospital three incisions have been tried : first one immediately above Poupart's ligament ; secondly, one nearer the iliac crest, and, lastly, one in the middle line. None of these seemed altogether satisfactory. The first was some way below the cæcum, and the appendix was reached with some difficulty ; the second exposed the cæcum readily, but gave no facilities for attempting to clean the peritoneal cavity ; and the last is too far away from the cæcum. It is probable that an incision along the outer border of the right rectus would easily expose the vermiform appendix if it is lying in its ordinary position, would be more likely to open a localised collection of pus, and would give the greatest facilities for cleaning the abdominal cavity if necessary. The epigastric artery would very likely be divided, but it can be secured without difficulty. If a localised collection of pus be found it is wiser merely to insert a drainage-tube, and not to attempt to clean the cavity lest the adhesions be broken down.

CHAPTER LXIV.

TAPPING THE ABDOMEN.—OPERATIONS ON THE ABDOMINAL VISCERA.—TUMOURS OF THE GROIN.

TAPPING THE ABDOMEN. PARACENTESIS ABDOMINIS.

THE abdomen often requires **Tapping**, either for general or encysted ascites. This operation, which is one of the simplest in surgery, may be performed as follows. The bladder having been emptied, the patient is seated on the edge of the bed or of a large chair, or if very weak lies on the side, and has a broad flannel roller, split at each end to within six inches of the middle, passed round the body in such a way that the untorn part covers the front of the abdomen, whilst the ends, which are crossed behind, are given to an assistant on each side, who must draw tightly upon them as the water flows. The Surgeon then, seating himself before the patient, and having ascertained that there is absolute dulness at the point at which he intends to operate, thrusts the trochar through the abdominal wall about two inches below the umbilicus. It was formerly customary to make a superficial incision with a scalpel through the skin and fat before inserting the trochar, but this is a needless complication. As the fluid escapes, the patient often becomes faint; but this may commonly be guarded against by continuing to draw upon the bandage so as to keep up good pressure on the abdomen. After all the fluid has escaped, the aperture must be closed with a strip or two of plaster supported by a pad and bandage, or a pad of iodoform or salicylic wool covered with collodion.

The syphon-trochar, Fig. 784, p. 733, will be found the most convenient instrument. It should not be too large lest the opening should leak after the operation. Should the situation of the accumulation of fluid in encysted ascites not allow its withdrawal by an aperture below the umbilicus, the abdomen may be tapped in any other convenient situation, except in the course of the epigastric vessels.

Ascitic fluid may be removed also by the aspirator, but in the abdomen this instrument presents no advantages over the ordinary syphon-trochar.

Dr. Southey, believing that a gradual withdrawal of the fluid is most advantageous, avoiding the risk of syncope and the necessity of bandaging the patient, has devised a small "drainage-trochar," which can be left in until the distension is relieved. The fluid flows steadily from it at the rate of from ten to twenty ounces per hour, through a fine india-rubber tube. This method of relieving ascites has been found very efficacious. It has no tendency to set up peritonitis, and is almost painless.

LAPAROTOMY FOR PERITONITIS.

The treatment of acute peritonitis from disease of the vermiform appendix has already been described in the last chapter. F. Treves, Lawson Tait, Barwell and others have advocated free incision and drainage in all cases of *purulent peritonitis* or *acute septic peritonitis* from whatever cause arising, and there is no doubt that this treatment is not only rational and justifiable but practically gives the patient the only chance of life. The operation presents nothing peculiar ; the abdominal cavity is best cleaned by irrigation with large quantities of water which has been previously boiled or of a warm solution of boracic acid (1 in 120). Carbolic acid and perchloride of mercury are dangerous if used in an efficient antiseptic strength.

Laparotomy for *perforative peritonitis in typhoid fever* has been performed by Bartleet and Lücke but without success. In one case the portion of gut including the perforation was excised and the ends united by suture. The patient died from shock.

In *chronic tubercular peritonitis* with ascites laparotomy and drainage have proved of signal service in a considerable number of cases. In several cases the abdomen has been opened under the supposition that the patient was suffering from an ovarian tumour. In one such case under the care of Sir Spencer Wells, the patient was alive and well twenty-two years afterwards. Knaggs and Clarke of Huddersfield have also published successful cases, and Lawson Tait asserts that a cure has resulted in 80 per cent. of those operated on. It is said that after simple tapping, the fluid reaccumulates, whereas this never happens if the abdominal cavity be opened and cleaned, even if the wound be at once closed. Further experience is required before it can be determined what cases require the operation. That the disease is by no means necessarily fatal without operation is a well-known fact. For the symptoms of the disease I must refer the reader to works on Medicine.

REMOVAL OF PORTIONS OF THE INTESTINE.

The operation of removal of a portion of the intestine for disease, or, as it is termed, **Enterectomy,** or if performed on the colon, **Colectomy,** was first attempted in 1833 by Reybard. Three inches of the colon were removed, the divided ends united by suture, and the patient recovered. In 1836 Dieffenbach removed a gangrenous portion of the intestine, and sutured the ends of the gut successfully in a case of strangulated hernia. Excision of a portion of the intestine remained one of the curiosities of surgery till within the last few years, during which it has been frequently performed by Gussenbauer, Czerny, Billroth, Madelung, Juillard, and many other continental Surgeons ; and by Bryant, Marshall, Treves, and others in this country. In 1882 Madelung collected 88 cases in which the intestine had been united by suture after complete division, with or without removal of a diseased portion. Seven of these were accidental wounds, and of these three died, and in one the result was not recorded. In 44 it was undertaken for gangrene of the gut in strangulated hernia, and of these 23 died ; in three for internal strangulation, and all these died ; in 22 for the cure of artificial anus, with 8 deaths ; and in 9 for tumours of the gut, with three deaths. These statistics well illustrate the nature of the cases in which this operation has been undertaken, and the degree of success that has attended it. The cases of tumour most adapted for removal are annular papillomata or columnar epitheliomata of the great intestine, before they have formed connections with surrounding parts. Such tumours may often be recognized by the symptoms of stricture and by feeling the growth through the abdominal wall. Tumours of the small intestine are extremely rare, and could scarcely be diagnosed by external examination.

The symptoms of the various conditions calling for enterectomy have already been sufficiently described, and it remains here only to give a brief description of the operation. If enterectomy is to be performed for artificial anus, the patient must be prepared by a few days limited diet and an aperient, followed by an enema to empty the bowel immediately before the operation. In other cases this is impossible. The general directions given on p. 790 must be carefully attended to. The patient must be thoroughly under the influence of the anæsthetic ; complete relaxation of the abdominal walls being a great assistance to the Surgeon. The incision must be made according to circumstances. In cases of tumour it is most conveniently placed over the growth.

The abdomen having been opened with all antiseptic precautions, the part of the intestine to be removed must be drawn well out so that not only the diseased part but two or three inches of the healthy bowel on each side may be clearly in view. A flat carbolized sponge may then be placed in the abdominal opening to prevent the protrusion of any more of the intestine. The part of the gut that has been drawn out should then be laid on a clean linen rag moistened with some warm antiseptic solution. A solution of carbolic acid (1 in 40) will be found the most efficient, and will not cause any irritation of the gut. If these precautions are carefully taken, should any fæcal matter escape on dividing the gut there is no danger of its entering the peritoneal cavity, an accident which would very probably be fatal. The next step is to apply a clamp about two inches distant on each side of the piece of gut to be removed, partly to restrain hæmorrhage and partly to prevent a copious escape of fæces. A pair of polypus-forceps, sheathed with pieces of drainage-tube, will, in the absence of a special instrument, answer the purpose very well. An india-rubber ring may be put round the handles to keep them closed. Barker recommends that a small hole should be made through the mesentery on each side of the piece of bowel to be removed through which pieces of rubber tubing may be passed and drawn round the gut with sufficient strain to prevent escape of its contents. The tubes may be fastened by means of forcipressure forceps. This plan is simple and efficient and does no injury to the gut. The piece of intestine to be removed is then cut through on each side with scissors ; in the case of small intestine, a V-shaped piece of the mesentery is removed with it. Any fæces that escape must now be washed away and the gut thoroughly cleaned, both inside and out, with an antiseptic solution. All bleeding is then arrested, and the sutures introduced in the manner described at p. 888, Vol. I. Czerny recommends that a double row of sutures should be applied, the first including the muscular and serous coats only ; the needle should be inserted about an eighth of an inch from the edge of the divided gut and made to appear on the cut surface between the muscular and mucous coats. It is then inserted on the other side again between the muscular and mucous coats and made to appear on the serous surface. All the stitches of the first row should be introduced before any are tightened. When they are all tied and cut short a second row is inserted, each stitch lying in an interval between two of the first row and including the serous coat only. Many Surgeons, however, prefer the simple Lembert's suture (p. 888, Vol. I.) and insert a single row. The best material for suture is fine hard twisted silk. It should have been previously rendered thoroughly aseptic. Czerny recommends boiling it for some time in a 5 per cent. solution of carbolic acid, but simply soaking in the solution for twenty-four hours is practically sufficient. The best needles are common fine sewing needles. Surgical needles with cutting edges should never be used. To save time it is most important that enough needles should be threaded for the whole operation before beginning. The stitches having been tightened, a line of sutures is carried along the V-shaped slit in the mesentery, if it be small intestine that is being removed, lest an aperture be left which might give rise to internal hernia from a coil of gut slipping through it. The clamps are then removed. The gut may then be kept out of the abdomen for a minute or two ; and should any fæces pass into it, it must be carefully examined for any leak. If it be perfectly tight, it is carefully cleaned and put back into the abdomen. In cases of operation for artificial anus or gangrenous gut in hernia, the external wound may have a drainage-tube inserted ; in others, it may be completely closed. In any case, an antiseptic dressing is applied.

In some cases of tumour of the bowel the patient's condition is such that it is impossible to submit him to an operation lasting often from an hour and a half to two hours. The tumour may then be removed, and the gut brought out at the wound so as to form an artificial anus. This operation has been performed by Bryant and Marshall. Bryant's patient survived, and was in good health a year after.

OPERATIONS ON THE STOMACH.

Pylorectomy.—The possibility of removing the pylorus for cancer was first suggested by Billroth in 1877. Gussenbauer and von Winiwarter subsequently experimentally demonstrated the possibility of removing portions of the stomach from animals. The first operation on the human subject was performed by Péan, who removed the pylorus in 1879 ; the patient however survived only five days. In 1880, Rydygier repeated the operation, but the patient died in a few hours. In 1880, Billroth performed the first successful operation. The patient was a woman aged 43 ; she made an uninterrupted recovery, and eat a mutton cutlet with the best appetite on the twentieth day after the operation. The patient, however, died four months after the operation from cancer of the peritoneum and retroperitoneal lymphatic glands.

The operation is practicable only in cases in which the pylorus has not formed such adhesions to the surrounding parts as to prevent its being drawn completely from the wound. Before the operation the patient must be confined to liquid food for some days. Immediately before commencing the stomach must be thoroughly cleaned with tepid water by means of the stomach-pump. The incision through the abdominal must be transverse, or nearly so, in direction, placed over the tumour, and free enough to expose the parts thoroughly. In Billroth's cases the external wound was four to five inches in length, crossing the middle line above the umbilicus. The great and small omentum must be carefully separated from the parts to be removed, all bleeding vessels being tied as divided. The pyloric part of the stomach is then drawn from the wound and laid on a carbolized cloth or a flat sponge, the subsequent steps of the operation being conducted outside the abdomen. The stomach and duodenum are then cut through with scissors. After each stroke of the scissors, any bleeding point is secured. Before dividing the duodenum, a few threads must be passed through its serous and muscular coats, lest it slip back into the cavity of the abdomen. The stomach is then fitted to the duodenum, by the removal of a V-shaped piece of its walls, either in the greater and lesser curvature, or at one side only. Finally, the duodenum and the stomach are united by sutures inserted as already described, the stomach returned to the abdomen, and the wound closed. The operation takes from one to two hours, and fifty to sixty sutures may be required. Success depends upon attention to antiseptic details, and prevention of the escape of any of the intestinal contents into the abdomen. In the after-treatment no food is allowed by the mouth for two or three days, the patient being supported by nutritive enemata. Billroth allowed his case sour milk on the third day.

Up to 1886 Billroth and his assistants, Wölfler and von Winiwarter, had excised the pylorus for cancer in 14 cases, with 8 deaths and 6 recoveries. Of the six who recovered, one was alive four years after, but in a dying state from cancer of the glands of the groin ; a recurrent growth was cut out of the scar in the abdominal wall two years after the operation. Another patient remained well after two years. The rest died of recurrence under one year. Of three patients operated on for simple stricture, two died. These results are, however, quite exceptional. Kramer has collected the results of 72 cases operated on for cancer ; of these 55 died directly from the operation. Of 10 cases operated on for cicatricial stricture, 4 recovered and 6 died. These results are not encouraging, and probably do not represent the real mortality. The chance of recovery from the operation is small, and recurrence is almost certain if the patient survives. It is doubtful, therefore, whether pylorectomy will retain a place amongst legitimate surgical operations.

Gastro-Enterostomy.—This operation was first performed by Wölfler in 1881, in a case in which pylorectomy was impossible on account of implication of neighbouring parts by the cancer. He therefore drew up a portion of the upper part of the small intestine, and applying it to the great curvature of the stomach, established a fistulous communication between them. The operation has been performed in Vienna in 8 cases with 5 deaths. In this country it has been successfully performed by A. E. Barker and H. Page. The earlier steps of the operation are the same as in pylorectomy. The stomach being exposed, a loop of small intestine is drawn up from below its cardiac end. Barker recommends that this should be emptied of its contents and occluded at two points in the way already described by means of two india-rubber tubes. A fold of the stomach is then pinched up and the empty gut applied to it, the two being held firmly together between the finger and thumb of the left hand. A longitudinal incision about one inch in length is then made in each, dividing the serous and muscular coats only. A line of interrupted suture is then inserted uniting the posterior edges of the divided muscular and serous coats of the small intestine and stomach. The stitches must be continued at each end for about one inch beyond the incisions passing through the muscular and serous coats, so as to fix the intestine firmly to the stomach. The mucous membrane may now be divided, and the rest of the operation finished in the usual way, a second row of sutures being afterwards inserted on both sides to give greater security. Gastro-enterostomy has given much relief in several cases, but it should not be undertaken if the patient can be kept in tolerable comfort by daily washing out the stomach.

Jejunostomy, or the formation of a fistulous opening in the upper part of the jejunum after attaching it to the abdominal wall, has been performed in one case by Golding-Bird, but it seems in every way inferior to gastro-enterostomy.

Digital dilatation of the Pylorus for Simple Stricture, or Loreta's Operation.—This operation was first performed by Loreta, of Bologna, in 1882. He exposed the stomach as if for pylorectomy, and opened it by a transverse incision between 5 and 6 cm. long near the pyloric end. He then inserted first the forefinger of the right hand, and, by a drilling movement, passed it through the narrowed pyloric orifice. He then inserted the left forefinger also, and stretched with some degree of force. The opening in the stomach was immediately closed by Czerny's suture, the abdominal wound brought together, and an antiseptic dressing applied. The operation lasted considerably under an hour. The patient was fed by enemata till the fourth day, when a little food was given by the mouth. Loreta is said to have performed this operation in 23 cases. It has been performed twice in New York with a fatal result. Two successful cases have been recently performed in this country, one by Hagyard, of Hull and one by F. Treves. In all the successful cases the patient has experienced great relief, and it is reported that there has been no case of recurrence of the stricture.

OPERATIONS ON THE LIVER.

Surgical procedures on the liver are required for the relief of abscesses, for the cure of hydatid cysts, and for some affections of the gall-bladder.

Abscess of the Liver.—Abscesses of the liver may be multiple or single. Multiple abscesses are usually the result of pyæmia, and admit of no surgical treatment. The single abscess generally occurs in patients who have lived in tropical regions, and is consequently often termed the " tropical abscess." The diagnosis of the disease belongs rather to the physician than to the Surgeon. It will be sufficient to mention here that the chief symptoms are fever, rigors, loss of appetite and health, occasional jaundice, with pain in the region of the liver, and sometimes in the right shoulder. There is increased liver dulness, and in the later stages bulging at some point corresponding to the surface of the liver, either in front or beneath the lower ribs behind. The abscess, if unrelieved, may burst into the pleura, lung, intestine or peritoneum, but in many cases it points towards the surface, either in the right hypochondriac region, or through the lower ribs behind. The diagnosis of the abscess is made certain by the use of the aspirator. It may be emptied in this way; but this rarely gives more than temporary relief. In order to effect a cure, it is in most cases necessary to evacuate the pus and drain the cavity. The mode of doing this will vary with the depth and the situation of the abscess. In all cases it should be done with the strictest antiseptic precautions.

According to Sir Joseph Fayrer it is always better to open in front if possible. If the abscess is distinctly pointing below the ribs, this may be done by a free incision, as adhesions will certainly be present between the opposed peritoneal surfaces. As the liver substance is cut, there is a most alarming gush of blood, but this soon stops if pressure be applied by means of a sponge. A large drainage-tube must then be inserted, and the case treated antiseptically in the same way as any other abscess. If the abscess point behind, under the lower ribs, it may be necessary to remove a portion of one of the ribs to admit a drainage-tube of sufficient size. If the abscess be deep, and indicated merely by bulging, without evident pointing, a free incision cannot be safely made. A large trochar may then be introduced, and left in for a few days, being replaced by a drainage-tube as soon as the track is sufficiently established. If the puncture is made in front, fatal peritonitis may ensue if no adhesions are present; to avoid this danger, Volkmann recommends that the surface of the liver should be exposed by an incision through the abdominal wall with antiseptic precautions. The wound may then be kept open by the insertion of a piece of carbolic gauze between its edges till adhesions have formed, when the abscess may be safely opened as above described. Injection of the abscess is not necessary if antiseptic treatment is carried out, but should this fail, and the discharge become foul, the cavity must be frequently washed out through the tube with some antiseptic solution.

Hydatids of the Liver.—A hydatid cyst is characterised by a gradual progressive enlargement of the liver, regular or lobulated in form, smooth on the surface and rounded at the edge. The general health suffers but little, there is no fever and no pain until the tumour reaches a considerable size and causes local peritonitis with the formation of adhesions. When the tumour is very large, suppuration may take place. For a more detailed description of this disease I must refer the reader to works on medicine.

Surgical interference should never be undertaken until the tumour reaches such a size as to become a source of inconvenience to the patient. If any doubt exists as to its nature this may be at once cleared up by the use of the aspirator, the fluid of a hydatid cyst resembling nothing in the body except cerebro-spinal fluid (Vol. I., p. 1008). The following are the chief modes of treatment which have been adopted in this disease :—

Acupuncture.—Many cysts have been cured after simple puncture by means of acupuncture needles repeated at short intervals. It appears that the fluid escapes through the punctures and is absorbed. This simple treatment has, however, very frequently been followed by suppuration, necessitating a free opening of the cyst to save the patient. It is said also that it may lead to the diffusion of the parasites through the peritoneal cavity with the formation of new cysts.

Electrolysis has been tried in several cases, but presents no advantages over simple puncture.

Aspiration frequently repeated has also cured many cases, and should always be adopted as the first effort at cure. It is not uncommonly followed by inflammation and suppuration of the cyst.

Injection of iodine after withdrawing some of the fluid by the aspirator does not seem to present any advantages over simple aspiration.

Drainage of the cyst by means of a cannula inserted on a trochar and tied in has been successful in some cases. It is always followed by suppuration, and is attended by considerable risk of peritonitis.

Opening the cyst by caustics as recommended by Récamier was formerly frequently adopted, the object being to form adhesions between the opposed surfaces of the peritoneum before the cavity was reached. It is tedious and painful, and is now seldom adopted.

Opening the cavity with removal of the parasitic cyst was first performed by Lindemann of Hanover. He divided the abdominal wall by a vertical incision under antiseptic precautions, and exposed the surface of the liver. The wound was then held open and a number of fine sutures passed attaching the peritoneum to the skin. Two strong threads were then passed through the cyst-wall parallel to the edge of the wound, by means of which it was drawn well out of the abdomen. It was then opened freely between the threads and the parasitic cyst cleaned out as far as possible. Finally the cyst-wall was closely sewn to the skin, a large drainage-tube inserted and an antiseptic dressing applied. Volkmann advises that if there are no adhesions the operation should be performed in two stages, the surface of the liver being first exposed, the wound plugged with carbolic gauze for five or six days till firm adhesions have formed between the liver and the parietal peritoneum, when the cyst is opened and treated as above described. Owing to the abundance of the discharge and its highly putrescible character the utmost care must be taken with the antiseptic dressings. Septicæmia has been the most common cause of death.

A suppurating hydatid cyst must be treated in the same way as a liver abscess.

Dilatation of the Gall-bladder and Cholecystotomy.—Dilatations of the gall-bladder, sometimes of very great size, are occasionally met with as the result of impaction of a gall-stone in the cystic duct. As the impaction takes place before the junction of the cystic duct with the hepatic, there is no jaundice, and the fluid distending the cyst is not coloured with bile. Impaction in the common bile-duct if unrelieved is fatal before any great dilatation takes place. In some cases the distended gall-bladder has been known to inflame, suppurate, and discharge externally, leaving a fistulous opening through which gall-stones have been discharged. Handfield Jones suggested that the gall-bladder might be opened and the obstructing calculus removed, and Marion Sims was the first to perform this operation, but without success. In 1878, however, Lawson Tait successfully accomplished the removal of the impacted gall-stone, and since then the operation has been performed in a large number of cases with but few deaths. The diagnosis of distended gall-bladder is not always possible. It is usually freely movable except at its upper attachment, and may resemble a renal tumour, or a hydatid cyst.

The operation is thus performed :—The cyst is exposed by a vertical incision at the outer border of the right rectus, all the precautions usual in abdominal operations being taken. The abdominal opening is then plugged with sponges and the cyst emptied with the aspirator. As it becomes lax it is drawn well up into the wound. It is then opened freely, and its interior cleaned out with a sponge, any loose stones being removed. Impacted calculi must be removed, if possible, with forceps, or they may be crushed with padded forceps and the fragments pushed back into the gall-bladder or down the duct with the fingers introduced into the abdominal cavity. The abdominal wound is then closed as far as possible, the edges of the opening in the cyst being attached to the skin and to the divided edges of the peritoneum. A good-sized drainage-tube is then inserted, and an antiseptic dressing applied. The tube must be retained as long as the discharge of bile makes it necessary. A fistula will be left after its removal ; but this will usually close without any further operative treatment.

SPLENECTOMY.

Knowsley Thornton has collected 35 cases of complete removal of the spleen, including two of his own, one of which was successful. Of these, 11 recovered and 24 died. Of the recoveries, one is said to have occurred in 1549, after removal for hypertrophy, and one in 1711, in which the spleen was "lying in a peritoneal abscess," and in a third, performed in 1855, the spleen was protruding from a wound. Excluding these three we have 8 recoveries and 24 deaths. In 3 cases this operation was performed for cysts and all recovered ; 13 for hypertrophy with 3 recoveries ; 2 for "wandering spleen" and both recovered ; 13 for leukæmia and all died ; and 1 for sarcoma which died. These statistics show that the operation is not justifiable in leukæmia and scarcely more so in simple hypertrophy. Cystic spleen is very rare, and has usually been mistaken for an ovarian tumour. When under this supposition it has been exposed, its removal seems perfectly justifiable. The operation presents nothing special. The tumour is exposed by a free incision, and isolated from surrounding parts, its pedicle being secured by ligature. If adhesions exist the splenic substance is very likely to be torn, an accident which is accompanied by fearful hæmorrhage which has in several cases been the immediate cause of death.

CYSTS OF THE PANCREAS.

Cysts of the pancreas are very rare. Eleven cases have, however, been collected by N. Senn, of Chicago, one of which was diagnosed and successfully operated on by himself. The cause of the formation of these cysts is often obscure, but in several cases they have arisen as the direct result of injury. The cyst forms a tumour which may reach a great size, and contain several pints of fluid. It is situated in the epigastric region, and as it increases it tends to push the transverse colon downwards and the stomach upwards. It reaches the surface above the umbilicus, being covered in front by the omentum. These cysts may cause jaundice by pressing on the bile-duct. The contents are colourless or brown from altered blood. The fluid contains much albumen and converts starch into sugar. In females they have most commonly been mistaken for ovarian tumours. The diagnosis is made by the situation of the cyst and by the character of the fluid removed by aspiration. In small cysts, Senn suggests that repeated aspiration might lead to a cure. Larger cysts should be treated by incision and drainage in the same way as hydatid cysts.

I cannot leave this subject without an expression of admiration at the great advance that has of late years been made in the treatment of diseases of the abdominal viscera by surgical operation, and a recognition of the merits of those Surgeons who have led the advance in this department of our art, and of the vast importance of the results achieved by them. But whilst thus freely recording my admiration for the successes that have been obtained, I must add a few words of caution to aspirants for distinction in this great field of practice. I would venture to remind them that an operation is not necessarily justifiable because it is practicable—that every act of operative audacity is not a triumph of sound and legitimate surgery—and that a patient's life may possibly be prolonged on conditions less tolerable than death.

DISEASES OF THE UMBILICUS.

Hæmorrhage from the Navel occasionally occurs in infants on separation of the cord. It is best treated by acupressure, a darning-needle being passed through the bleeding point and a piece of silk twisted round it.

Ulceration of the Navel is occasionally met with after the separation of the cord in new-born children. It must be treated by cleanliness and the application of some simple ointment. In adults, especially when very fat and uncleanly in their habits, eczema followed by ulceration is not uncommon in the navel. It must be treated by syringing with boracic acid lotion and the application of boracic acid ointment. Sometimes a prominent fungating mass of granulations may form, which requires destruction with nitrate of silver. Soft and hard chancres have been met with on the navel, and a purulent discharge resulting from gonorrhœal infection is said to have been observed.

A **Warty Growth** is occasionally met with in children springing from the hollow of the umbilicus. It is best removed by ligature.

Epithelioma of the Navel is a rare disease. Should it occur the tumour must be removed freely, if necessary opening the abdominal cavity and closing the aperture by sutures.

Umbilical Fistulæ.—*Fæcal fistulæ* at the umbilicus may arise from strangulation and sloughing of an umbilical hernia. They are also occasionally congenital, resulting either from a protrusion of a diverticulum from the ileum or of a portion of the small intestine into the cord and its accidental inclusion in the ligature at birth. In other cases they arise from perforation of the small intestine by chronic ulceration, usually tubercular, with the formation of a circumscribed abscess amongst the coils of the intestine, finally discharging at the navel. The treatment of these fistulæ is extremely unsatisfactory. The application of the cautery to the orifice is of little use, and plastic operations almost invariably fail. If the disease does not give much trouble it is better treated by the application of a pad and attention to cleanliness. If there is a complete artificial anus after gangrenous hernia a cure must be attempted by the means already described in the chapter on hernia. *Urinary Fistulæ* are very rare, and result from imperfect closure of the urachus. They admit of no treatment. *Biliary Fistulæ* also have been met with; their mode of origin is uncertain, and they also do not admit of treatment. *Purulent Fistulæ* also are described by some writers; these are merely collections of pus, usually in the abdominal wall, which have discharged at the navel. They are best treated by enlarging the opening and inserting a drainage-tube.

TUMOURS OF THE GROIN.

Tumours of the groin may develop primarily in that region or descend into it from the abdomen. In making the diagnosis the first point is to ascertain whether pulsation is present. *Pulsating* tumours are either aneurisms, pulsating sarcomata or fluid tumours with communicated pulsation. The distinction of these diseases is fully given at pp. 113 and 325, Vol. II. *Non-Pulsating Tumours* may be divided into the *reducible* and *irreducible.* The reducible tumours are either hernia, varix of the saphena vein, or abdominal abscesses passing under Poupart's ligament. The diagnosis of these various diseases is given at p. 856, Vol. II. In distinguishing the irreducible tumours, irreducible hernia must first be excluded. The remaining tumours may be fluid or solid. The fluid tumours are chronic abscesses or cysts, the lymphatic glands or cystic growths of various kinds. The diagnosis here is easy : the irregular hardened outline of glandular abscess, its rapid development, and softening from a previously indurated state, will distinguish it from the tense, clearly-defined outline, smooth and elastic feel of the slowly developing and very chronic cystic growth.

The *Solid* tumours may be enlarged glands, a retained testicle, or new growths. The new growths may be simple or malignant. When malignant they may be primary sarcomata or secondary cancerous masses following epithelioma of the penis or skin of the leg. The history of the case, the feel of the tumour, the rapidity of its progress, the extent of contamination of neighbouring parts, and the other signs that serve as diagnostic differences between simple and malignant growths, will enable the Surgeon to make the diagnosis with sufficient accuracy.

The *treatment* of most of these conditions has already been described, but a few words may be said here on the removal of solid or cystic tumours of the groin by operation. In undertaking such proceedings the relation of the growth to the great vessels must be carefully considered. If the tumour merely presses on the vessels, causing, perhaps, much solid œdema of the limb, the removal may be attempted, but if it seems to implicate and surround them and to be fixed to neighbouring parts it is wiser not to attempt any operation.

CHAPTER LXV.

DISEASES OF THE LARGE INTESTINE AND ANUS.

CONGENITAL MALFORMATIONS.

Congenital Malformations of the anus and rectum are by no means unfrequent. They may exist in various degrees, which may most conveniently be arranged under the following heads.

Narrowing and Partial Closure of the Anus.—The canal continues pervious, but not sufficiently so to allow of the bowels being completely emptied, the contraction usually merely admitting a full-sized probe. In some cases the obstruction appears to depend upon constriction of the anal orifice, in others upon an imperfect septum stretching across it.

Treatment.—This consists in notching the contracted anus with a probe-pointed bistoury, and then introducing a sponge- or laminaria-tent, so as to dilate it to the proper size, to which it must be kept by the occasional introduction of a bougie.

Complete Closure of Anus.—The anus may be completely closed by a membranous septum stretching across it, usually having a raphé along the central line, and a slight depression, through which the dark meconium can be seen, and on which an impulse can be felt. This constitutes perhaps the most common form of malformation that is met with.

Treatment.—In this variety an incision must be made through the septum along the middle line, and across on each side, when the meconium will freely escape. The four angular flaps that are left must now be removed, and the aperture kept open by the introduction of a well-oiled plug.

Occlusion of Rectum above the Anus by a Membranous Septum.—The anus may remain open ; but, at a distance of about half an inch or an inch from its aperture, the rectum will be found occluded by a perfect membranous septum stretching across it. This is a rare and somewhat puzzling kind of malformation, as the infant that is the subject of it will be found to labour under intestinal obstruction, and yet, on examination, the anal orifice will be found perfectly formed. The Surgeon will, however, detect it by introducing a probe or the end of his little finger into the anus. It can readily be brought into view by inserting the nose speculum (Fig. 668), and throwing light up the bowel by means of a laryngeal mirror.

Treatment.—The operation, of which the following are the details, will be found to be successful. 1. The child is put in the lithotomy position. 2. A trochar-cannula is then passed down to and pressed against the septum. 3. The trochar is next passed down the cannula and through the septum. 4. The trochar is then withdrawn, and the cannula left in. 5. A probe is passed through the cannula, which is then slipped out over it and along the probe, or a director which may be substituted for it, a narrow-bladed pair of dressing forceps is pushed up and opened out so as to dilate the opening in the septum.

During this process, the retained fæces will have escaped. The aperture must be kept free by the occasional introduction and expansion of the forceps or of a laminaria tube.

It is important to observe that, although the anus may be perfectly formed and patent, with a canal above it about half an inch long, the rectum may be entirely absent, the sigmoid flexure terminating in a dilated pouch opposite the sacral prominence. In such cases it is of course impossible to reach the gut through the anus.

Complete Absence of Anus.—The anus may be completely absent, being blocked up by a dense mass of fibro-cellular structure, from half-an-inch to an inch in thickness, above which the rectum terminates in a kind of *cul-de-sac.*

Closure of Anus with Absence of Rectum.—It has already been stated that in some cases of perfect formation and patency of the anus the rectum is absent, but more commonly the anus is closed when the whole of the rectum is wanting; the intestine (colon) terminating in a large and expanded pouch, situated high up at the brim of the pelvis, opposite the sacral prominence. A case of this kind differs from the last only in the extent of the occlusion, and cannot indeed be distinguished from it until the Surgeon has made an incision in the site of the anus, and has failed to reach the gut at the usual distance.

Treatment.—In these cases the Surgeon must first make an attempt to reach the bowel from the perinæum, failing which, two courses are open to him. He may open the colon in the left iliac fossa, or he may open it in the left lumbar region by Amussat's operation.

1. **Perinæal Incision.**—The perinæal incision has the advantage of being in the natural situation of the anus, and of being easily practised and usually successful in all those cases in which the anus only is imperforate, the rectum being present. In those cases in which there is congenital absence of the rectum this operation must necessarily fail. The operation is thus performed :—An incision about an inch in length should be carefully made from the point of the coccyx forwards. The dissection requires to be carried with caution to a considerable depth along the mesial line; and the Surgeon taking the curve of the sacrum and coccyx for his guide, and bearing in mind the relations of the bladder and large vessels in the neighbourhood, carefully proceeds in search of the gut, which may be found at a considerable depth from the surface. A probe may be passed into the urethra of a male child, or the vagina of a female, to serve as a guide to the position of these canals. The danger of wounding the bladder must also be considered, and may be materially lessened by emptying this viscus by pressing over the pubes before commencing the operation. In four instances of this kind on which I have operated, it was necessary to proceed to a depth of at least one and a half or two inches before the bowel was reached; which, on account of the narrowness of the wound and the small size and important relations of the parts is not an easy matter. When the gut is reached it must be punctured and the meconium allowed to escape.

It is of the utmost importance both for the immediate result of the operation and for the prospect of ultimate success that the mucous membrane of the gut should be brought down and fixed to the lips of the external wound. Unless this be done, the line of incision between the gut and the aperture in the integuments will degenerate into a fistulous canal; which, like all fistulæ, will have a tendency to contract, and will be a source of endless embarrassment to the Surgeon and to the patient. If the mucous membrane can be brought down to and fixed to the opening in the integument, this source of inconvenience will be removed, and the patient will be saved all that danger which results from the passage of the meconium over a surface of recently incised areolar tissue. This, however, can be done only when the intestine terminates at a short distance from the surface. If the perineal incision be two or three inches in depth, there will be little probability of the Surgeon being able to bring the intestine down to such an extent.

For some considerable time after the operation, the aperture should be kept dilated by means of bougies ; or a gum-elastic or pewter tube, through which the fæces are allowed to escape, may be fixed in the part.

I have several times operated in this way on imperforate children ; but in all instances unsuccessfully. In one case, there was an anal aperture, but with complete occlusion of the rectum. I operated on the fourth day, first attempting to reach the gut through the anus ; but, failing in this, performed the lumbar operation on the left side.

As the Surgeon has no means of ascertaining, before making his incision, whether the rectum be one inch or three inches from the surface, he must cut into the perinæum in order to obtain the necessary information. If after going as deeply as he dare venture, he does not encounter the bowel, there is no alternative but to open the intestine through the abdominal wall, or to leave the child to its fate. In this alternative, the Surgeon must either open the colon in the left iliac region or in the left loin.

Iliac Incision.—The *advantages* claimed for the iliac incision, or Littre's operation, are, that it is easy of performance, and that whether the Surgeon reach the colon or not, he is certain to hit upon some part of the intestinal tube, which may be drawn forwards and opened. The *objections* raised are—that the artificial anus is in an inconvenient situation, that there is danger of peritonitis, as the peritoneum is necessarily wounded, and that the sigmoid flexure may not present in the wound, and a portion of small intestine may be opened instead. These objections are not, however, quite so great as they at first appear. The artificial anus being situated in front has this advantage, that the patient can easily pass his motions into a properly shaped curved pan held in the groin, and can afterwards clean the parts himself. Moreover, diffuse peritonitis by no means necessarily follows. The mortality is no doubt great. Amussat stated, that of 21 children thus operated on, only 4 ultimately recovered ; but Richard of Brest, writing in 1859, gives much better results, for he records 12 cases as having occurred in the practice of himself and other Surgeons in that town, 7 of which recovered.

Lumbar Incision.—The lumbar incision, or Amussat's operation, has been often successfully practised on imperforate children. The *advantage* of this method is the possibility of opening the colon in this situation without wounding the peritoneum. The *objections* lie in the frequent malposition of the colon and in the still more frequent presence in the infant of a long meso-colon. Moreover, the space, especially in a fat infant, is very limited. It thus frequently happens that the peritoneum is unavoidably wounded. Curling, for these reasons, preferred Littre's operation to Amussat's in these cases. In fact, the arguments for and against the two operations are so evenly balanced that it is difficult to express any strong preference for one over the other. I have myself preferred Amussat's, and have performed it in more than one case. In performing the operation it must be borne in mind that the kidney is very large, extends far outwards, may be enveloped in very little fat, and may thus be easily wounded. If the operation succeeds, the result is very satisfactory. I saw, some years ago, a boy, eight years of age, who had thus been operated upon in Mexico for congenital absence of the anus and rectum. He was in good health, well-nourished, had no great trouble with the artificial anus which was covered with a truss-pad, and suffered only occasional inconvenience from prolapse of the mucous membrane. There was a kind of sphincter-like action in the muscles about the orifice, by which the finger was gripped.

Absence of Anus: Opening of Rectum into other Canals.—The anal orifice may be absent, and the gut may open into one of the neighbouring mucous canals, as the vagina, the urethra, or the bladder. In such anomalous cases there is usually, I believe, but little to be done, except to restore the anal orifice if possible; but, if this be impracticable, to make a lumbar opening, and then to take the chance of the other preternatural communication closing. This it will sometimes do; and cases have occurred in which, although the whole of the meconium with flatus had escaped *per urethram*, yet, on opening the rectum, the abnormal communication seemed gradually to close, the fæces being directed into their proper channel. In a case in which I was once consulted, there was imperforate anus and rectum, and the bowel protruded as a red fleshy tube, discharging meconium, and about four inches in length, from the anterior abdominal wall, just below the umbilicus, and immediately above an extroverted bladder.

STRICTURE—SIMPLE, SYPHILITIC AND MALIGNANT.

Stricture may occur in any part of the large intestine, but with very varying degrees of frequency in different portions of that gut. Excessively rarely met with in the ascending or transverse, of unfrequent occurrence in the descending colon, it becomes more common in the sigmoid flexure, and very frequently occurs at about the junction of this portion of the colon with the rectum. In the rectum itself it is most commonly found either at the upper part, from four to six inches above the anus, or else a little above that aperture.

The frequent passage of small quantities of liquid fæces, with occasional constipation, should always lead to a suspicion of stricture.

It is of three kinds: 1, the *simple*, dependent on simple thickening of the intestinal coats; 2, the *syphilitic;* and 3, the *malignant*, consisting of a cancerous growth of the walls of the gut.

1. **Simple or Fibrous Stricture,** though occasionally occurring in the transverse or descending colon, is most frequently met with in the sigmoid flexure or at its junction with the rectum, or at the upper part of this gut, from four to six inches from the anus. This form of stricture of the large intestine commonly occurs in elderly people, and with special frequency in women. It is usually the result of long-continued diarrhœa or of chronic dysentery. In some cases the narrowing is really caused by inflammatory thickening outside the gut, especially in women who have suffered from pelvic cellulitis after labour. In such cases the stricture is seated just within reach of the finger.

The **Symptoms** of simple stricture of the rectum consist at first of some difficulty in defæcation, the patient being obliged to strain at stool. The fæces will also appear to be flattened, narrowed, or furrowed, and in many cases, more especially as the stricture advances, are passed in the form of small scybala, with occasionally a kind of spurious diarrhœa, consisting of the passage of the more fluid intestinal contents, whilst the solid matters are left behind. At the same time there is very commonly pain in defæcation, with occasional passage of some mucus or blood; and dyspeptic symptoms, with flatulent distension of the abdomen, are apt to come on. If the stricture be within four or five inches of the anus, it may be reached with the finger, and its precise situation and diameter ascertained. If above this point, it must be examined by the introduction of a well-greased bougie, attention being paid to the curve which the rectum makes laterally, as well as from before backwards. In introducing a bougie in order to ascertain the presence of a stricture above the upper end of the rectum, but little information can be gained in many cases, as the point of the instrument is apt to hitch in folds of the mucous membrane, or opposite the promontory of the sacrum; and thus, its onward passage being prevented, there may seem to be a constriction, which in reality does not exist, and unless care be taken the mucous membrane may actually be lacerated, and the instrument forced through it into the peritoneal cavity. In other cases, the bougie will appear to pass, when in reality its point, meeting with an obstruction, curves downwards into the rectum.

The **Progress and Termination** of a simple stricture vary in different cases. Many persons who present all the symptoms of this simple stricture of the rectum will live on in very good general health through a long series of years. In others the contraction may go on increasing, until at last complete occlusion takes place, with all the symptoms of obstructed bowels. This condition usually comes on slowly, and, after the obstruction is complete, life may continue for several weeks; but in some instances the obstruction seems to take place rather suddenly, and with all the symptoms of acute intestinal strangulation, death occurring in a few days. This is probably always due to volvulus or kinking of the dilated bowel above the stricture. Abscess occasionally forms in the neighbourhood of the stricture; and, passing down into the pelvis, may burst either into the ischio-rectal space, or into the vagina, or may present upon the nates. The discharge of pus from this source, as well as from the mucous membrane lining the stricture, which falls into an ulcerated state, may induce extreme emaciation and hectic, to which the impairment of nutrition consequent upon the disturbance of digestion adds materially.

Treatment.—The bowels should be kept moderately open, but purgation carefully avoided, as it is a source of much irritation. Castor-oil, Carlsbad salts, or saline aperient mineral waters in small doses suit best. The diet should be carefully regulated, and the strength kept up. An occasional enema will often give considerable relief. Small glycerine enemata are especially useful.

The *surgical* treatment of simple stricture of the rectum consists in dilating the canal at its constricted point. If this be within reach of the finger, the dilatation can be readily carried out. If it be above the upper part of the rectum, and the stricture be tight, it is extremely difficult to introduce the proper instruments with certainty. When the stricture is low down, so that the end of the finger can be introduced into it, it may readily be dilated by introducing a rectum-bougie every second day, and gradually increasing the size of the instrument. If the stricture yield but slowly, and be very tight and indurated, I have found it a convenient plan to introduce a sheathed probe-pointed bistoury into it and to notch it towards its posterior aspect, where this may be done without danger to the peritoneum. A tent of compressed sponge or of laminaria digitata should then be introduced, and left in for twelve hours. On its withdrawal, bougies may more readily be passed; or the dilatation may be carried on by means of tents. When the stricture is above the reach of the finger, a good deal of management will be required to make the bougie enter it. This is best done by placing the patient on his left side, and using a moderate-sized elastic bougie, softened in warm water and well greased, which must be passed without the employment of any force. When once the Surgeon has introduced one, others can readily be made to follow in the same track. The great danger in introducing a bougie high up, is that of mistaking the obstruction offered by its point coming into contact with one of the valvular folds of mucous membrane present in this situation, for that of the stricture, and, by pushing on the instrument, perforating the bowel—an accident that would probably occasion fatal peritonitis. During the introduction of bougies, the bowels must be kept regular by means of a lenitive electuary, and the occasional use of emollient enemata. If much pain or irritation should be occasioned by their presence, opium should be administered internally or in the form of suppositories. Though a simple stricture of the rectum may be much relieved by the use of bougies, it is seldom, I think, cured by this means; there being a great tendency in it to contract as soon as the treatment is discontinued.

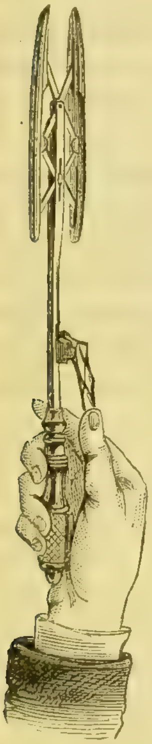


Fig. 828.—Rectum-Dilator.

Dilatation may sometimes be very conveniently effected by the use of Todd's dilator (Fig. 828). This is introduced closed, covered with a thin vulcanized india-rubber sheath, so as to avoid nipping the mucous membrane. It is then expanded to the required extent by pressing on a trigger in the handle.

If complete obstruction occur, purgatives must on no account be given. An endeavour should be made to relieve the patient by the use of enemata of olive-oil, and the strength should be supported by a diet that is nourishing, at the same time that it leaves little or no solid residue. Opium in small doses frequently given will relieve the pain and prevent sickness; under this treatment the bowels may eventually act after a considerable lapse of time. In a case to which reference has already been made, the obstruction gave way after it had lasted for about five weeks, some hardened fæces with bloody mucus being discharged and speedily followed by abundant motions. Should the obstruction, however, continue, and the patient consequently be in imminent danger of death, the intestine should be opened, if possible, by Amussat's operation, performed in the way already described (p. 895, Vol. II.).

Syphilitic Stricture of the Rectum is met with usually within easy reach of the finger, and chiefly in young women under thirty, rarely in men. The pathological changes to which it is due have been already described in the Chapter on Syphilis, Vol. I., p. 1148. The fact that this disease is almost exclusively met with in women has led to the idea that it may be due to direct infection of the bowel or to extension of disease from the vagina, but there is no evidence to support this view. It is always a tertiary affection, and is seldom associated with any affection of the vagina. It is almost exclusively met with amongst the poorer classes, and in hospital practice. To the finger introduced into the bowel it feels as if there were an irregular thickened cicatricial constriction of the mucous membrane. This may be limited to the lower part of the bowel, but frequently extends beyond the reach of the finger. The examination causes the patient the most intense pain, as there is often ulceration in the constricted region. Sometimes under proper treatment the ulcers may be made to heal, and then the dense irregular cicatricial bands alone will be felt. There are usually evidences of constitutional syphilis. I have seen these syphilitic ulcerations extend into the vagina, so as to establish a recto-vaginal fistula. In one case under my care death resulted from perforation of the upper part of the rectum into the peritoneum. The motions are usually passed with much pain, and are mixed with blood and pus. The general health is at first good, but gradually gives way under the pain and the exhaustion from loss of blood, and discharge.

Treatment.—The patient must be put under the usual constitutional treatment for syphilis. If ulceration is still present the best treatment consists in passing bougies of cocoa-nut butter, each containing about four to five grains of iodoform, into the rectum once a day. If this does not succeed, similar bougies, containing a small quantity of bichloride of mercury, not exceeding $\frac{1}{16}$ of a grain, may be used instead. In many cases nothing succeeds so long as the diseased surface is irritated by the passage of fæces, and then colotomy must be performed as the only means of giving relief. Should the ulcers heal without necessitating colotomy the cicatricial contraction resulting from them may be treated in the same way as a simple stricture. The extent of the disease usually, however, makes this form of stricture extremely intractable.

Cancer of the Rectum—Malignant Stricture.—The form of cancer met with in the rectum is almost invariably the Columnar Carcinoma, or as it is sometimes called Adenoid Cancer. Its structure has been fully described in the Chapter on Tumours (Vol. I., p. 1067). In the rectum it varies somewhat in structure in different cases. In some the epithelial structure is very abundant, the growth being composed of a closely packed mass of tubes resembling enlarged crypts of Lieberkühn, between which lie the vessels, supported by a delicate connective tissue closely infiltrated with small round cells. In others the glandular element is much less developed, the fibrous stroma being more fully developed, and showing in some cases a tendency to contract like that of a scirrhus. All degrees may be met with between these two extremes. The clinical features vary with the structure. The softer varieties grow more rapidly, implicate surrounding structures more widely, and tend to infect the lymphatic glands and internal organs, but lead to a less complete stricture of the gut. The firmer varieties grow slowly and often exist a long time without giving rise to secondary growths, while from their tendency to contract they cause great narrowing of the gut. The softer forms usually appear as flat cauliflower growths springing from the inner surface of the gut, and tending in most cases to spread circularly round it. They are usually extremely painful, and bleed readily when examined. They slough early, and cause extensive destruction of the bowel. The firmer varieties form hard, nodulated growths projecting into the gut, greatly narrowing its calibre. They ulcerate slowly and bleed less readily.

True *scirrhus*, that is to say, glandular carcinoma, with firm fibrous stroma, is said to have been met with in the rectum. If such be the case it is certainly very rare. *Colloid cancer* also, arising apparently from colloid degeneration of a columnar carcinoma, has been met with, but is exceedingly rare.

The tumours described as *Encephaloid* have probably been soft malignant sarcomata commencing in the gut or in its coats, but these cases are so rare that it is impossible, at present, to speak with certainty as to their structure.

Most usually cancerous disease is seated from three to five inches above the anus, and may implicate a considerable portion of the bowel, extending upwards rather than downwards, giving rise to considerable contraction, ending in some cases in complete occlusion of the gut.

Symptoms.—Cancer of the rectum is met with chiefly in middle life, but sometimes does not occur until advanced age. Both sexes are equally liable to it; if anything, it is more frequent in women than in men.

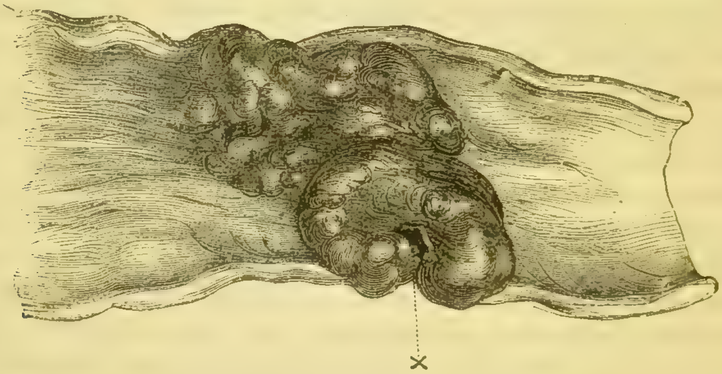


Fig. 829.—Cancer of Upper Part of Rectum. At × perforation leading to fatal Peritonitis took place, during administration of an Enema.

It is very insidious in most cases in its early manifestations. A sense of uneasiness, a tendency to diarrhœa, a slight discharge of blood or mucus, a feeling as if the patient had piles, are usually the only early evidences of the development of this distressing disease. After a time the rectal pain becomes very severe. There is now a constant feeling of pain and weight in the gut, with a sensation as if the bowels had not been completely relieved, together with the discharge of mucus, blood, or pus, and some flattening of the fæces. On exploring the parts with the finger, the lower portion of the rectum will usually be found unaltered, while the tip of the finger will come in contact with the contracted, hardened, ulcerated, and rugged mass, at one part of which an opening will be found leading into an irregular cavity which passes up through the cancerous mass to the healthy gut above. The patient experiences most intense suffering during defæcation, in consequence of the passage of fæces over the raw and ulcerated surface. This pain is not confined merely to the diseased part, where the sensation is of a burning character, but usually radiates round the loins and down the thighs, and is so severe that the patient looks forward to each action of the bowels with the greatest dread, and restrains it as long as possible. The whole nervous system at last participates in this continually recurring suffering; the countenance becomes anxious; the spirits are depressed; sleep and digestion are destroyed. The patient's condition is indeed truly miserable, between the dread of excessive suffering when the bowels act, on the one hand, and the fear of impending obstruction on the other. In many instances he is worn out by this suffering, occasionally combined with the constitutional cachexy induced by the contamination of the system and the development of secondary visceral growths. Not unfrequently the misery is much increased by the formation of fistulous openings in the bowel, and communication between it and neighbouring parts, such as the vagina, bladder, or urethra, with cancerous implication of them. Flatus as well as fæces thus get entrance into the bladder or vagina; the flatus passing out with a rush, the fæces sometimes obstructing the urethra, and often very seriously irritating the bladder, producing strangury and great pain.

Death may put an end to the patient's sufferings in several ways: by exhaustion from pain and continuous discharge, together with constitutional cachexy; by perforation of the cancerous mass, which, ulcerating through at some point, opens into the peritoneal cavity, or by hæmorrhage, inducing fatal collapse; and in other instances by fæcal obstruction, as in the case of simple stricture. The reason why intestinal obstruction is not more common than it is in cancer of the rectum is, that in many cases the diseased mass ulcerates and necroses more rapidly than it grows into the bowel, and thus an irregular chasm is left in its centre, through which the fæces pass.

Treatment.—This must necessarily in a large proportion of cases be merely palliative. The bowels must be relieved by occasional doses of castor-oil or by emollient enemata. The patient's sufferings may in many cases be much relieved by limiting him to a diet composed solely of material not likely to leave any solid residue, such as carefully prepared and strained arrow-root and meat-broths of various kinds, to which a little brandy or wine may be added. If the patient at the same time be kept warm in bed in the recumbent position so as to economise force as much as possible, he may maintain his strength fairly well on a comparatively small quantity of food. Small doses of opium may be given to relieve pain. On this diet one action of the bowels about every three weeks will be quite sufficient. It will usually occur spontaneously without the necessity of administering a purgative. If there is much pain, hypodermic injections of morphia, often to a large amount, are required to lessen the patient's distress.

As further palliative treatment *Colotomy* may be required. This operation is performed for one of three reasons:—1. To relieve the intense agony resulting from the passage of fæces over the ulcerated cancerous mass; 2. To relieve the suffering and great discomfort occasioned by the fæces passing into the bladder or vagina; 3. For the relief of more or less complete obstruction, giving rise to distension of the abdomen, with retained fæces. Colotomy as a palliative has proved most successful in affording the desired relief; by its means life may be prolonged as well as rendered more endurable. Attempted dilatation by means of bougies, the application of caustics, or crushing the tumour by means of the finger-forceps, as recommended by Amussat, are worse than useless. They cause great pain and irritation, hasten ulceration, and aggravate the disease.

Excision of the Tumour. Partial excision of the Rectum or Proctotomy is an operation which has lately been revived with considerable success. Récamier, Vidal, and others attempted the removal of the tumour when situated near the anus by ligaturing its base and allowing it to slough away. The only advantage in such a proceeding is the absence of hæmorrhage, but this is more than counterbalanced by the dangers arising from the presence of the sloughing mass, by the uncertainty of perfect removal, and by the pain it gives rise to.

Removal of the disease by excision of a portion of the rectum was first performed, according to Velpeau, by Faget in 1739. He took away an inch and a half of the circumference of the gut and cured his patient. The operation was revived in 1826 by Lisfranc, who removed portions of the rectum in nine cases, with five recoveries. The operation, however, fell again into discredit. In 1854, Chassaignac introduced the écraseur, and applied it to removal of rectal growths. Since then Nussbaum and Volkmann in Germany, Jordan, Allingham, Holmes and others in this country, have done much to revive the operation; and in 1880, Harrison Cripps published an interesting work which has added much to our knowledge of the subject. The cases suitable for removal are not numerous, according to Cripps, forming about one in five of those that come under observation. The conditions which render the operation justifiable are the following:—The patient must not be too old, and must be in fair health; the growth must be so situated that the finger can be passed fairly beyond it, and it must be freely movable, not having implicated surrounding parts. The most favourable cases are those limited to one side, especially the posterior. It is an important question how far the dissection can be carried upwards without wounding the peritoneum. Cripps, who has carefully investigated this point, states that in the male the distance from the recto-vesical pouch to the anus is two and a half inches when the bladder is empty, and an additional inch when it is distended. In the female the distance from the recto-uterine pouch to the anus is somewhat greater.

The removal of a malignant growth from the rectum is accomplished as follows:—If it be very small, and situated very low down, it may be possible to bring it into view by forcible dilatation of the anus. This is done by inserting the two first fingers of each hand into the anus and forcibly dragging it open. After this the anus will usually be sufficiently relaxed to allow of the affected portion of the gut being seized and drawn out to such an extent as to allow of the free removal of the growth by the écraseur, scissors, or Paquelin's cautery. Cases in which this is practicable are, however, very rare.

The removal of a portion of the bowel, including the whole circumference or a considerable part of one side, can be safely performed only when the anus has been enlarged by incision, as suggested by Denonvilliers. The operation is thus performed. The rectum having been thoroughly cleansed with an enema immediately before the operation, the patient is placed in the lithotomy position, and a curved sharp-pointed bistoury, guarded by the left forefinger, is passed in at the anus; the handle is then raised so that the point is made to pierce the gut and appear superficially close to the tip of the coccyx exactly in the middle line; the parts between the coccyx and anus are then divided by a single cut. If more room be required during the operation it may be obtained by removing the coccyx. The bleeding must now be arrested, and a stout ligature may be passed through on either side, by which the two edges of the wound may be held widely apart. An incision is then carried from the margin of the wound on one side in a curved direction round the anus to a corresponding point on the other side. If the anus itself is healthy this may be made at the junction of the mucous membrane and skin. The gut can now be separated posteriorly without any difficulty by means of the finger, aided by the scissors, at the attachment of the levator ani. When the sides are separated the gut must be drawn backwards and separated by careful dissection from the vagina in the female, or urethra and prostate in the male. To avoid any risk of wounding the urethra a large silver catheter should be passed at this stage of the operation, which will be clearly felt from the wound. The gut having now been separated it may be cut away by means of the écraseur, scissors, or Paquelin's cautery, The écraseur has the advantage of preventing hæmorrhage, which in so deep a wound might be difficult to arrest. Paquelin's cautery has the disadvantage of hardening the edges of the wound so that it is difficult to ascertain if they are free from disease. During the operation bleeding must be arrested, partly by the pressure of sponges and partly by the use of forcipressure forceps. The hæmorrhage can in this way be easily kept under control. and seldom causes any great trouble. After the operation it is useless to try to bring the mucous membrane down to the anus. As Cripps points out, the stitches always give way and nothing is gained. The wound should be thoroughly sponged out with some antiseptic solution, chloride of zinc, (gr. 40 to ℥j), being by far the most efficient. It may then be dusted with iodoform. In most cases it is better to leave the whole incision to close by granulation, as free drainage is then certain to be obtained. Volkmann recommends closing the anterior part and inserting a large drainage-tube behind, but there seems little advantage in so doing. The after-treatment consists in well syringing the wound once or twice a day with some antiseptic solution and the application of a little iodoform. The bowels must be prevented from acting for ten days or a fortnight by proper diet and the administration of opium. Healing takes place slowly, and the mucous membrane becomes drawn down considerably towards the skin. A strictured anus almost necessarily results if the whole circumference of the bowel have been removed, but this may usually be kept sufficiently patent by the constant use of bougies. Incontinence of fæces is more rare. Cripps states that it occurred in seven cases out of thirty-six, and in six others there was a slight escape when the motions were liquid.

Removal of a part of the circumference is a much more successful operation. It is performed in the same way as that just described, but the healthy mucous membrane and the corresponding part of the anus must be preserved uninjured, a longitudinal incision with scissors being carried up the bowel on each side of the morbid growth. It is seldom followed either by incontinence of fæces or serious stricture of the bowel.

Wound of the peritoneum is a serious but not necessarily fatal accident. If the opening be small and within reach an attempt may be made to close it by sutures. If this cannot be done, according to Bardenheuer the patient is given the best chance of life by the introduction of a full-sized drainage-tube into the peritoneal pouch from the rectum.

The mortality from the operation is considerable as judged by statistics. C. Kelsey of New York collected 140 cases, and states that in 22 of these rapid death followed; in 10 from peritonitis, in 4 from pelvic cellulitis, and in 3 from hæmorrhage. In only 6 had a permanent cure resulted. There seems no doubt, however, that in well selected cases, taken early, the operation holds out a fair prospect of prolonged relief or even cure.

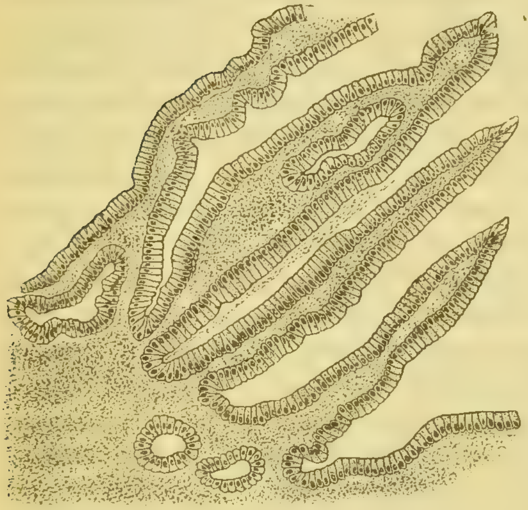


Fig. 830.—Papillary polypus of the rectum (× 200).

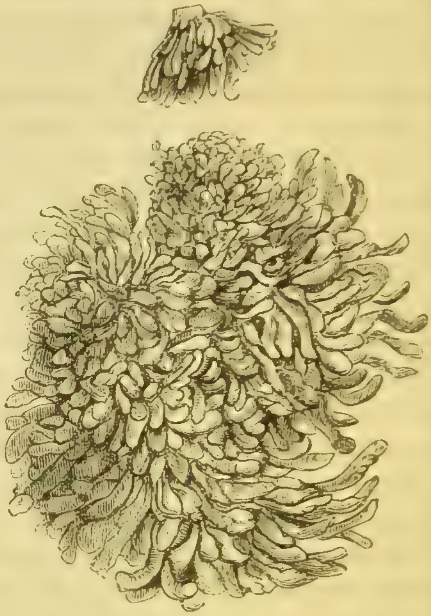


Fig. 831.—Large Papillary Polypus of the Rectum.

Intussusception of the Rectum as a consequence of a malignant growth is a very rare condition. In a case of this kind under the care of Barker in University College Hospital the tumour projected from the anus with each action of the bowels and bled freely. Digital examination showed that the reflexion of the rectal wall was situated about three inches from the anus. A double row of stitches was passed through the entering and reflected layers, and the apex of the intussusceptum including the tumour was cut away. The patient made a rapid recovery, passing a motion on the sixth day.

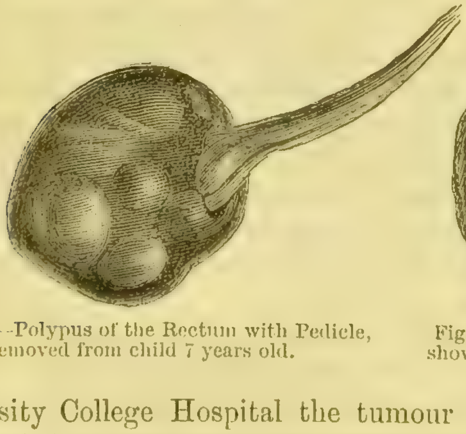


Fig. 832.—Polypus of the Rectum with Pedicle, removed from child 7 years old.

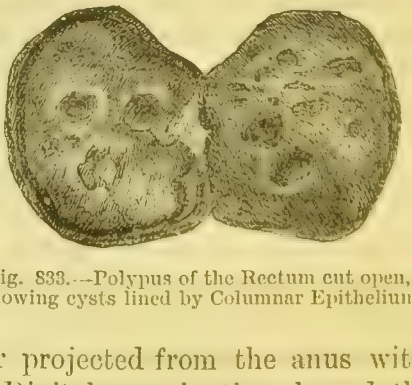


Fig. 833.—Polypus of the Rectum cut open, showing cysts lined by Columnar Epithelium.

Cancer of the Anus.—The anus is rarely affected by extension of cancerous growths from the rectum. More commonly the disease is primary, and it is then always squamous epithelioma (Fig. 401, p. 1065, Vol. I.). It forms a nodular projection, often resembling a swollen external pile, for which I have more than once seen it mistaken. It ulcerates later than the same disease in other situations, the mass often reaching the size of a pigeon's egg before the surface gives way. If limited in extent and detected in good time it may be advantageously excised by an operation similar to that for removal of the lower part of the rectum.

Sarcomata of the Rectum are very rarely met with. Rokitansky has described a nodular form of spindle-celled sarcoma. I have seen such growths forming large and somewhat pale tuberous masses projecting into the interior of the gut and even protruding through the anus, giving rise to the same train of local symptoms as characterize cancer of the gut, but with less pain. In such cases as these the disease may, if limited or pedunculated, be removed by the écraseur. By means of this instrument I have removed from the inside of the gut a tumour of this kind nearly as large as the fist. Recurrence may of course be expected, but the patient will get relief for a time.

Papillomata.—Large papillomata, the papillæ of which branch repeatedly, and are covered by columnar epithelium, are occasionally met with in the rectum. They closely resemble cancer, but are recognized by their slow growth and by their being pedunculated. They cause hæmorrhage and some obstruction of the bowel. They can be readily removed by the écraseur or by ligature, and seldom return. The accompanying figure (Fig. 831) represents a pedunculated mass which was removed from the rectum of a man by J. Marshall. Fig. 830 is taken from a portion of the same growth.

Polypi are by no means uncommon in children, and should always be looked for when a child passes blood from the bowel, and suffers from prolonged irritation. They are a common cause of prolapsus of the bowel in children, and may give rise to some irritability of the bladder and thus simulate stone. They are sometimes fibrous in structure, smooth on the surface, and covered with columnar epithelium. In other cases they are lobulated (Fig. 832) or papillary, and may contain cysts lined with columnar epithelium (Fig. 833). They are easily removed by the application of a ligature, or by twisting the neck if it be long.

In adults similar growths are less frequently met with. They are most common near the anus, and in some cases are found associated with a small intractable ulcer at the point at which the free end touches the gut. They are best removed by ligature of the neck, after which the body may be cut away.

RECTAL FISTULÆ.

Fistulous openings occasionally occur between the rectum and the bladder in men; or between this gut and the vagina in women.

Recto-Vesical Fistulæ are not common, and usually result either from cancerous ulceration, establishing a communication between the rectum and the bladder; or from a wound of the gut during the operation of lithotomy. In rare cases they arise from tubercular abscesses in the vesiculæ seminales or prostate, opening into the rectum and bladder simultaneously. In these cases the urine escapes *per anum* in greater or less quantity, occasioning constant irritation or excoriation, with a sort of spurious diarrhœa; and the wet state in which the patient is kept by the dribbling of urine gives rise to an offensive ammoniacal odour about him. If the communication between the rectum and bladder be cancerous, fæculent matter and flatus pass through the opening, and escape from time to time by the urethra ; perhaps even more abundantly than the urine does *per anum*. There is this difference then between the traumatic and cancerous fistulæ, viz., that when traumatic the chief escape is from the bladder into the rectum ; when cancerous, of the contents of the rectum into the bladder. It is remarkable how little irritation is often set up by this admixture of fæces with urine in the bladder. The fistulous aperture in the rectum, if traumatic, can readily be detected by passing the finger into the gut, or examining its interior with the speculum ani ; when cancerous it is too high up for this.

Treatment.—If the fistula be cancerous, nothing can be done in the way of treatment beyond keeping the parts clean, or diverting the fæces by colotomy ; but if it be traumatic in its origin, of small size, and more especially if it be recent, its closure may not unfrequently be accomplished by touching it with nitrate of silver, or the thermo-cautery through a speculum ani. If, however, the fistula be of old standing, and the aperture large, cauterization will not succeed ; and the only mode of treatment that can be adopted will be to introduce a grooved staff into the bladder, and cut through the sphincter upon this, thus laying the parts into one, and converting the anal into a perineal fistula. By draining the bladder, granulations will spring up, and deep union be accomplished. In cancerous recto-vesical fistula of a painful character, colotomy may be had recourse to with every prospect of mitigating the patient's sufferings (Vol. II. p. 894), and of thus prolonging life.

Entero-Vaginal Fistula.—It has happened that a communication has been set up between the small intestine and the vagina, an artificial anus in fact forming in this cavity. These cases, however, are very rare, and may indeed be looked upon as incurable. Roux and Casamayor endeavoured to establish, by a deep and difficult dissection, a communication between the small and large intestine ; but the operation, as might have been expected proved fatal.

Recto-Vaginal Fistulæ may arise from two causes : 1st, sloughing of the posterior wall of the vagina, in consequence of undue pressure exercised upon it during parturition ; and 2nd, its perforation by syphilitic ulceration. They may be ranged in two classes : those consisting of a button-hole opening (and these are often syphilitic), and those complicated with more or less extensive laceration of the perinæum. The size of these fistulous openings when uncomplicated with rupture of the perinæum, varies greatly ; in some cases there is merely a small perforation, in others there may be loss of the greater portion of the posterior wall of the vagina. Whatever their size, they are necessarily sources of very great discomfort and annoyance to the patient. The recognition of the disease is easy ; the escape of the fæces and flatus into the vagina being obvious, and digital or ocular examination by means of the speculum at once detecting the seat and extent of the aperture. As there is just the possibility of a communication existing between the vagina and the small intestine, it may be useful to bear in mind that, in this case, the matter that escapes is yellower and less stercoraceous than when the rectum is opened.

The **Treatment** of the non-syphilitic fistula will vary according as the fistula is simple, or complicated with lacerated perinæum.

Simple uncomplicated Recto-Vaginal Fistula, if it be small and recent, may occasionally be closed by attention to cleanliness, at the same time that its edges are touched with the nitrate of silver, a hot iron wire, or the platinum loop. If it be very large, the greater part of the posterior part of the vagina having been destroyed, it will probably be incurable ; but even here the patient should not be left to her fate, and some operation should be attempted which may lessen its size, even if it do not completely close it. The kind of fistula which is here met with usually consists of a circular aperture, that readily admits the point of the finger, situated just above the sphincter ani. The operation for the closure of a recto-vaginal fistula of this kind consists, after emptying the patient's bowels by purgatives and an enema, and the bladder by the catheter, in introducing a duck-billed speculum into the vagina, and freely paring the edges of the aperture. As the fistula is always low down, this is readily done by placing the patient on her back, and tying the hands and feet together, as in lithotomy. The vaginal mucous membrane should be dissected off towards the fistula. The next point is to bring its edges into apposition, in a direction transverse to the axis of the vagina ; and in doing this, the recommendation made by Copeland and Brown, of dividing the sphincter ani, should always be acted on, as it is a most important auxiliary to the success of the operative procedures that are required ; for, as there is always loss of substance in these fistulæ, there is necessarily a tendency to tension on their sides when any attempt is made to draw them together ; and it is also of importance that any muscular movement about the parts in the neighbourhood of the fistulæ should be arrested, as this might otherwise break down union after it had taken place between the edges. The sides of the fistula must then be drawn into apposition by silver sutures introduced by means of the hollow needle. I have always found that the sutures are most easily introduced if passed *from above downwards*—the mucous membrane being then drawn upon by the needle, which more readily transfixes it than if it be introduced from below upwards, when it is left to push the membrane before it. The wires are thus passed across the fistula and out through the vaginal mucous membrane, half an inch beyond the freshened surfaces, care being taken not to include the rectal mucous membrane. They may then be twisted, or brought through a leaden plate and clamped by shot. The success of the procedure depends not only on the proper completion of the steps of the operation, but greatly on the after-treatment. This should consist in the administration of opium, to prevent the bowels from acting for ten or twelve days ; indeed, until firm union has taken place between the edges. They may then be moved by means of laxatives and oleaginous enemata carefully given. During the treatment, the parts should be disturbed as little as possible, the patient lying on her side. The water should be drawn off by a catheter twice a day. The parts should be well syringed twice a day with boracic acid lotion or some other simple antiseptic. The patient must be kept upon a moderate diet, and the stitches may be left in for eight days, when they must be carefully removed. Should any point of the fistula not be closed, the application of the nitrate of silver may induce proper union of it.

If, as very commonly happens, the *Recto-Vaginal Fistula be complicated with a Lacerated Perinæum*, the operation for that condition, described at p. 899, Vol. I., must be performed, and the edges of the fistula, after being deeply pared, brought together at the same time. Sometimes in these cases it happens that the perinæum unites, leaving an aperture above this in the recto-vaginal septum; if this aperture be but small, it may be closed by its edges being touched from time to time with the actual cautery; if it be large, so as to allow the introduction of the finger, I believe that it is generally useless to attempt to close this aperture by itself; but the perinæum should again be divided, and the whole operation repeated.

When the recto-vaginal fistula is of syphilitic origin, there is usually some degree of stricture of the rectum associated with it, and an extensively excoriated and diseased state of the vaginal mucous membrane. In these cases the sufferings of the patient are often very great, and the only means of relief open to the Surgeon is the performance of colotomy.

Entero-vesical Fistulæ.—A fistulous communication may be established between the intestine at some point above the rectum and the bladder. The fistula usually forms between the sigmoid flexure of the colon and the upper and left lateral part of the bladder. It is possible that the small intestine may be the seat of this fistula, but most certainly such an occurrence is rare.

In these entero-vesical fistulæ there is usually a long antecedent history pointing to cancer of the intestinal wall. Some obscure hardness, with tenderness or occasional shooting pains, is then met with, and suddenly the patient observes in his urine some dark offensive deposit, which, on examination, proves to be fæculent matter, with or without the escape of flatus by the urethra. In other cases, after more than usual pain, with rigors and the constitutional symptoms indicative of suppuration, the urine will be found to be loaded with pus of a stinking character. In a few days fæces will appear in it, and flatus pass through the urethra. In either case, adhesion has formed between the intestine and the bladder. Perforation takes place, and the intestinal contents escape either directly into the bladder or through the cavity of an intervening abscess. The bladder-irritation is usually at first but trifling; but after a time cystitis is developed and phosphates deposited.

The *treatment* in the early stages should consist in clearing out the bowels with castor-oil, and then locking them up for 10 or 14 days with opium, so as to give the fistula a chance of closing. Should this fail, the bladder must be washed out twice daily, and if the patient's sufferings increase so as to render life a burden, colotomy may be resorted to if it is the great intestine that communicates with the bladder, or cystotomy may be done, and thus a wider outlet for fæces, urine, and flatus, afforded through the perinæum than the urethra permits.

ULCER AND FISSURE OF THE ANUS.

This disease, though trivial in point of size and in its pathological relations, is of great practical importance, on account of the excessive local pain and great constitutional irritation to which a patient labouring under it is often subject. Ulcer and fissure commonly exist together in this situation, though it by no means unfrequently happens that the two conditions occur separately. The ulcer is usually of small size, seldom larger than a silver three-pence, of a circular or longitudinal shape, situated between the folds of the mucous membrane in the upper part of the anus, or rather the lower part of the rectum, just above the ring or ledge formed by the sphincter, and is usually met with towards the posterior part of the gut on one side of, or opposite to, the point of the coccyx. Occasionally more than one ulcer exists in this situation. If a fissure accompany the ulcer, it commonly leads from this across the face of the sphincter to the verge of the anus; but in many cases one or two fissures, sometimes even three or four, exist without any ulcer. The fissures are usually slightly indurated and cord-like, extending merely through the mucous membrane, scarcely, if at all, implicating the deeper structures; and not unfrequently their external termination is concealed by a small red pile or flap of integument.

The existence of the ulcer may usually be determined by exploring the rectum with the finger, which, if practised in these examinations, will detect a small, soft, and velvety patch at the diseased spot; on touching this, the patient will usually complain of acute and burning pain. It may be brought into view by examining the rectum with a speculum (Figs. 834 and 835), but an anæsthetic will usually be required to do this. The fissure may always be detected by everting the mucous membrane of the anus, and by lifting up or turning aside the pile that covers the lower end of the crack. During this examination, it will usually be found that the sphincter ani is in a more or less spasmodically contracted state, admitting the finger with difficulty.

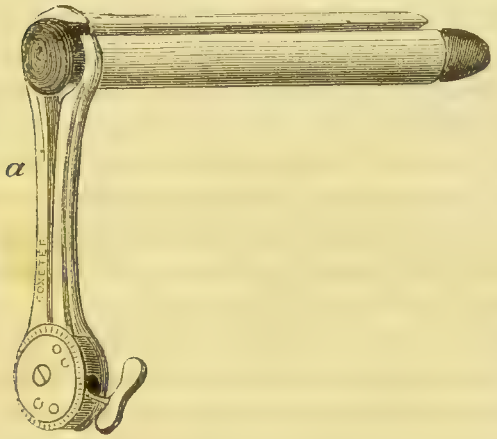


Fig. 834.—Anal Dilator.

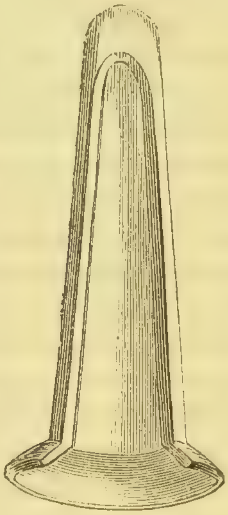


Fig. 835.—Speculum Ani.

Symptoms.—The symptoms of ulcer or fissure in the anus are very characteristic. The patient complains of pain, usually of a severe burning character, on the passage of a motion, especially if a hard one; it commonly occurs at the time of defæcation, but occasionally commences a few minutes afterwards, and continues from half-an-hour to several hours. This pain is very severe, and peculiarly wearing and burning; it is generally most felt opposite the sacro-iliac articulation, but not unfrequently radiates round the pelvis or down the thighs. In many cases it produces a good deal of continued irritation about the genito-urinary organs, giving rise, in the male, to symptoms of spasmodic stricture; a frequent desire to urinate, tenderness about the prostate, and seminal emissions. The pain is sometimes so severe that the patient avoids defæcation as long as possible, and even abstains from food with the view of lessening the necessity for the frequency of this act. Very commonly in women, the pains produced by the rectal disease simulate those occasioned by uterine irritation; and in both sexes they may after a time become continuous, and be attended by a good deal of constant uneasiness in sitting, so that the patient is obliged to raise the hip of the affected side. There is often a streak of pus or blood on the fæces, and commonly a good deal of mucous exudation, with some tenesmus on defæcation: but in some instances these symptoms are altogether absent, and the patient never suffers any local inconvenience except from the pain. The constitutional irritation is often very great, the nervous system generally sympathizing with the local mischief. The countenance becomes pale, anxious, careworn, and the patient's expression is indicative of constant suffering.

Causes.—This affection most commonly occurs in women, especially in those of a hysterical temperament and weakly constitution. In some cases it seems to have arisen from injury during labour. When met with in men, it is most frequently seen in debilitated subjects, and appears to be the result of a broken state of health. In persons who have been the subjects of the chronic dysentery of hot climates, I have several times noticed a peculiar form of patchy ulceration within the rectum, of an extremely irritable and very intractable character. It is not uncommon to find a small polypoid growth immediately above the ulcer, hanging down upon the raw surface, and apparently concerned in maintaining the disease. I have in several instances observed it in women to be of a syphilitic nature, and in such cases it is situated generally towards the side or the anterior part of the anus.

The rectum may be injured by blows or falls upon the sacrum or coccyx, and fissure, laceration of the mucous membrane, or rupture of the muscular fibres, may ensue from these accidents.

Treatment.—The treatment of fissure or ulcer of the anus, when the disease is met with in the early stages, may sometimes be successfully conducted by the application of nitrate of silver, and the use of an anodyne or astringent suppository. I have found a very excellent and useful suppository in this and many other painful affections of the anus to be composed of 2 grains of extract of belladonna, 2 grains of the acetate of lead, and 4 of tannin, made up to a proper consistence with a little cocoa-butter. This may be introduced into the rectum every night; the bowels should at the same time be kept gently open with castor-oil, or the lenitive electuary. In those cases in which the disease has been of some standing these means will not suffice, and it becomes necessary to have recourse to a very simple operation to effect a cure. This consists in dividing the affected mucous membrane through the ulcer or fissure, with possibly some of the subjacent fibres of the sphincter, by which the part is set at rest, and cicatrization speedily takes place. The relief after the operation is usually immediate: indeed, after its performance, a patient who has been suffering severely for months or years, will often get complete and almost instantaneous relief. The merit of introducing this plan of treatment into surgical practice is due to Sir B. Brodie. Boyer had previously recommended that the sphincter should be cut completely across, in order that its action might be paralysed; but Brodie found that the ulcer could be made to heal as readily by the limited incision above mentioned. The operation is done by introducing the left fore-finger into the rectum, guiding along it a straight probe-pointed bistoury, and then cutting downwards and outwards, carrying the knife about the eighth of an inch in depth. No dressing is required after this operation; but, if the incision do not readily heal, it should be touched with the nitrate of silver.

The patient's bowels should be well opened before the operation, and a dose of castor-oil may be given on the second or third day after it. During the process of cicatrization it will often be advantageous to give iron, and to put the patient on a nourishing diet. As a substitute for incision, forcible digital dilatation of the anus under an anæsthetic has of late been extensively practised with very good results. The floor of the fissure is usually torn somewhat deeply, so that the effect resembles that of incision.

Spasmodic Contraction of the Sphincter Ani is usually associated with fissure or ulcer of the anus, or inflammatory irritation of some neighbouring organ ; but occasionally it occurs without this complication, and in all cases it may be connected with a neuralgic condition of the part. In hysterical women neuralgia and spasm are especially apt to occur ; though it is not improbable that, in many of the so-called cases of neuralgia of the anus, some positive disease, such as a small ulcer or fissure, may be detected on close examination, as I have several times been able to verify. The *Treatment* of contraction of the sphincter, whether associated with neuralgia or not, consists in the employment of local sedatives, especially the extract of belladonna, gr. j. to gr. ij. as a suppository ; the bowels being kept relieved by enemata and confection of senna. Should these means fail, the patient must be anæsthetized, and the sphincter forcibly dilated with the Surgeon's fingers.

Atony of the Rectum is common in middle age, in those who lead sedentary lives, and especially in women. It is a consequence of habitual constipation, and in its turn aggravates that condition, the walls of the rectum becoming expanded and pouch-like. It may occasion the retention and impaction of hardened fæces. A mass of clayey consistence, and as large as the fœtal head, forming in the rectum and interfering seriously with defæcation, becomes a source not only of great discomfort but of serious ill-health. Like all retained excreta it slowly poisons the system, giving rise to foul breath, dirty greyish complexion, and mental depression. The *Treatment* of atony of the rectum consists in scrupulous care in emptying the bowels by the administration of cold enemata. If impaction of fæces have occurred, this is to be remedied only by putting the patient under chloroform, forcibly dilating the sphincter with the hand, and breaking down the hardened mass with a lithotomy scoop or spoon, washing it away with enemata, and thus clearing out the bowel.

ABSCESS AND FISTULA.

Abscess not unfrequently occurs in the vicinity of the rectum and anus. It may either be superficial, being confined to the muco-cutaneous structures, and presenting the ordinary characters of acute subcutaneous abscess ; or it may be deeply seated, forming in the ischio-rectal fossa. It is these ischio-rectal abscesses that are of most practical importance. They may be of two kinds—Acute and Chronic.

Acute Ischio-rectal Abscess forms deeply in the fossa, with throbbing, shooting, and stabbing pains, through the anus, rectum, and perinæum ; on examination, a hard brawny substance may be felt in the areolar tissue by the side of the gut, either by examination from without, or by exploration through the rectum. It speedily softens, and will, unless an outlet be made for it, burst either externally, or into the cavity of the gut, or both ways. (See p. 959, Vol. I.)

Chronic Ischio-rectal Abscess, occurs insidiously in persons of cachectic, broken, or phthisical constitution. Without much pain or local inconvenience, a collection of pus forms, which is usually limited to one side of the ischio-rectal fossa, but in other cases acquires considerable magnitude, extensively denuding the gut, in fact, almost surrounding the rectum, and then spreading widely on the nates, presenting all the ordinary characters of a chronic abscess. This kind of purulent collection may form in this as in any other situation in the body, as the result of congestion or of some local irritation. I have several times seen it follow kicks, blows, or bruises of the lower part of body, or as a consequence of the lowering of the vitality of the mass of adipose tissue in the ischio-rectal fossa by a weakly person sitting on a cold stone, or standing for a long time on ice or snow. In other cases the mischief appears to originate around the prostate, and an abscess forming in this situation may find its way down by the side of the rectum. Sir B. Brodie attributed these abscesses, and the consequent fistulæ, to perforations of the mucous membrane ; and although I think he exaggerated the frequency of this mode of production of the abscess, yet there can be no doubt that, in some instances at least, it occurs as the result of perforation of the bowel ; either by ulceration from within, by the formation of a fissure, or by some foreign body, as a fish-bone, transfixing it. These abscesses are most common in young adults, not unfrequent in middle age, but rare at either of the extremes of life. I have, however, seen several cases in children—two or three years of age—and they may occur in septuagenarians.

In the *treatment* of these abscesses, the principal point is to prevent extensive denudation of the gut. In order to do this the abscess must be opened, as soon as the formation of pus can be ascertained to have taken place, by making a free, and, if necesssary, a deep incision into the ischio-rectal space by the side of the bowel. Unless this be done, it may either burst into the interior of the gut, or spread widely upon the nates and then give way. The pus that is let out is always extremely offensive, even though not mixed with any fæculent matter ; the close neighbourhood of the bowel appearing to determine some change in it that renders its smell stercoraceous. After the evacuation of the abscess the patient feels easy, and thinks that all is well, the discharge gradually lessening and the cavity contracting ; but it does not close, and a fistula will be left, in which fæculent matter, perhaps, accumulates from time to time, giving rise to fresh outbreaks and extensions of the disease.

Anal Abscess.—Besides the two forms of abscess just described as occurring in the ischio-rectal fossa, another is commonly met with to which the term "anal abscess" may be applied. It commences in the submucous tissue of the gut immediately above the anus. Its cause is not always evident. It may arise from suppuration taking place beneath an inflamed pile, from wound of the mucous membrane by some solid body such as a fish-bone in the fæces, or from the formation of a caseating tubercular nodule in the submucous tissue. The pus thus formed burrows downwards between the mucous and muscular coats of the bowel till it reaches the anus ; here it passes out beneath the skin and forms a small rounded swelling at the margin of the anus. If unrelieved it may burrow still further in the subcutaneous tissue. The pus in this case lies superficial to the sphincter. These abscesses may be acute or chronic ; when chronic they are frequently tubercular, advancing slowly and containing thick curdy pus. They usually burst both internally and externally, and are the most common cause of the ordinary fistula in ano. By early opening and dressing with wet boracic acid lint and frequent bathing with a concentrated solution of boracic acid they can sometimes be got to heal without leaving a fistula. If they are tubercular this seldom happens, and the best treatment is to lay them thoroughly open into the bowel, to scrape the surface well with a sharp spoon, and to dress them with iodoform ointment.

Fistula in Ano.—The sinus left by the contraction of the cavity of an ischio-rectal or anal abscess constitutes a *fistula in ano;* an affection that has attracted a good deal of attention from the frequency of its occurrence, and from the difficulty of curing it without having recourse to operation.

Extent.—When following an anal abscess the fistula is very limited, being merely the sinus left in the submucous areolar tissue of the anus after the bursting of the superficial collection of pus in this situation, extending to a short distance up the gut inside the sphincter. This constitutes the most common variety of the disease. In a fistula resulting from an ischio-rectal abscess the track passes outside the sphincter in the surrounding areolar tissue, extending always as high as the upper margin of that muscle, and frequently stretching to a considerable distance up the side of the gut. Most frequently the lower and external aperture of the fistula is single, and is situated by the side of the anus in the ischio-rectal fossa, just beyond the sphincter; but not unfrequently the aperture is in the perinæum, or posteriorly in the coccygeal region. Occasionally there is a fistulous opening on each side of the gut; or several openings may exist, and then sinuses extend from these upwards and outwards to a considerable distance, undermining the integuments of the perinæum about the buttocks, even stretching away towards the trochanters, and opening at a great distance from the bowel. These extensive fistulæ and sinuses are frequently connected with stricture of the gut; but they may occur without this in old and neglected cases of the simple disease.

The fistulæ are usually oblique, but straight in their direction from a point half an inch or an inch from the anal aperture, running upwards to above the sphincter. In some cases they are tortuous; and, occasionally, when opening at a distance from the gut, and extensively undermining the integuments, they are angular, having, as it were, an elbow at that point where the superficial sinus meets the deep fistula. This peculiarity will prevent the passage of a probe through their whole length until the external sinus has been slit up, and the commencement of the deep fissure reached, and may lead to the supposition of the fistula being more superficial than it in reality is.

Varieties.—Fistula in ano is said to be **Complete** when it communicates by one end with the rectum, and opens by the other upon the external surface. It is said to be **Incomplete** when it has only one aperture, whether that be external or internal.

Complete Fistula is the most common form. It probably arises in the majority of cases from some source of irritation seated within the bowel, by which the mucous membrane of the rectum has been perforated, and an abscess has formed in the submucous areolar tissue or outside the gut. The external opening in this form of fistula is usually from half an inch to an inch from the margin of the anus; though it may be seated at a greater distance than this, as upon the hip. It is commonly small, and has a vascular granulation projecting from or occluding it; and a thin purulent discharge usually drains away from it in small quantities, moistening the surrounding integuments. The internal opening is usually situated just above the sphincter, where the rectum begins to expand. But the fistula does not terminate at this internal aperture; for in the majority of cases it runs up a considerable distance further into a kind of *cul-de-sac.* The internal aperture may readily be detected by introducing a blunt curved probe into the fistula; when, by a little management, it may be carried through the inner opening. In some cases, the existence of this may be ascertained by examining the interior of the bowel with a speculum, and by injecting water into the external opening.

Incomplete or **Blind Fistulæ** may be of two kinds. When there is no internal perforation, a mere sinus having been left by the bursting of an abscess, the fistula is termed *blind external.* When there is only an internal aperture, it is called *blind internal.* The blind external fistula is readily recognized by its being found that the probe does not penetrate the interior of the gut. The blind internal is not so readily detected; but in this case it will generally be found that the patient suffers from an occasional and tolerably abundant discharge of pus from the interior of the bowel; that there is a good deal of tenderness, with some brawny induration in the ischio-rectal fossa on one side of the anus; and that the pus may be made to well out in some quantity by pressing upon this part. On passing the finger into the rectum, the ragged internal aperture in the gut through which the pus exudes may readily be felt. In most cases the opening can be seen by the help of a speculum, and a hooked probe passed into it.

Treatment.—Operative interference is usually necessary. It is true that in some rare instances the fistula may be made to close under the influence of constitutional remedies, aided, perhaps, by stimulating its interior with nitrate of silver, or by touching it with a probe dipped in nitric acid. This kind of treatment is, however, successful only in the blind external fistula, several instances of which I have seen recover in this way. Occasionally in elderly people a blind internal fistula will be found, which, falling into a very chronic state and discharging little, is a source of but very trivial discomfort, and will continue for years without giving rise to serious local inconvenience, or in any way disturbing the general health. In such cases, I believe, there is often far less risk in leaving the fistula untouched, than in subjecting the patient at an advanced period of life to the dangers of an operation. When the fistula is complete, the only plan of treatment that offers any chance of success is to lay it freely open into the bowel; so that if it pass external to the sphincter, this muscle, which tends to prevent the closure of the sinus, will be paralysed, and the fistula, being laid open from the bottom, will heal by granulation. Various plans have been devised for the division of the fistula, and much ingenuity has been expended in attempts to discover simpler and less painful modes of effecting this than by the knife, but hitherto without success.

The **Operation for fistula in ano** should not be performed indiscriminately in all cases and at all periods of the disease. If the fistula be dependent upon stricture of the gut, and more especially if this be of a malignant character, it is evident that no operation can be attended with a chance of success, and none should be attempted. So, also, if the patient be cachectic and broken in health, more especially if he be suffering from tubercular disease of the lungs, it is well to improve his constitutional powers before undertaking an operation, lest the wound that results may not readily cicatrize. It is well also to wait until the disease has assumed a somewhat chronic form before proceeding to the division of the sphincter; if this be done early after the bursting of the abscess, or at any time if there be much inflammation going on, the wound is apt to assume a somewhat sloughy condition, and to heal with difficulty. The most important question usually connected with the operation of fistula, is the propriety of performing it in phthisical subjects. It is a well-known fact that fistula in ano is especially apt to occur in consumptive individuals, and it is often a nice point to determine whether an operation should or should not be performed in them. Theophilus Thompson maintained that the co-existence of fistula with phthisis appeared to retard the progress of the latter disease, acting as a derivative; and this opinion was at one time generally accepted. I have, however, in several cases found considerable advantage result from operating for fistula in the early stages of phthisis, or in suspected cases of that disease, the patient's health having considerably improved after the healing of the fistula. But in confirmed, and still less in advanced phthisis, no operation should ever be practised; as the wound will not heal, and the patient must be weakened by the additional discharge.

The operation for *complete* fistula should be performed in the following way. The bowels having been well cleared out the day before with a dose of castor-oil, and an enema administered on the morning of the operation, the patient should be laid on his left side, with the nates projecting over the edge of the bed; a probe must then be passed through the fistulous track into the rectum, and the Surgeon, introducing the forefinger into the gut, feels for the end of the instrument; he then passes a short strong-bladed probe-pointed bistoury of about the size and shape of that represented in the annexed figure (836) through the fistula, using the probe as a guide, though in some cases this may conveniently be dispensed with. When he feels the end of the knife projecting into the rectum through the internal aperture of the fistula, he hooks his forefinger over it (Fig. 837), after withdrawing the probe, and by a sweeping and pressing cut, raising the handle of the instrument at the same time that he pushes down its point, brings both finger and blade out at the anal aperture, cutting through the whole thickness of the parts between this and the fistula. Care should be taken to cut in a direct and not an oblique manner, lest a flap or fold be left which will interfere with the proper healing of the wound. In performing this operation, the Surgeon should cut with his left hand if the fistula be upon the left side; and in either case should be careful not to wound his own finger, as such cuts often prove troublesome in healing. Where the external aperture or apertures of the fistula are at some distance from the gut, the integuments being undermined to a considerable extent, perhaps thinned, soft, and bluish, all the superficial sinuses should be

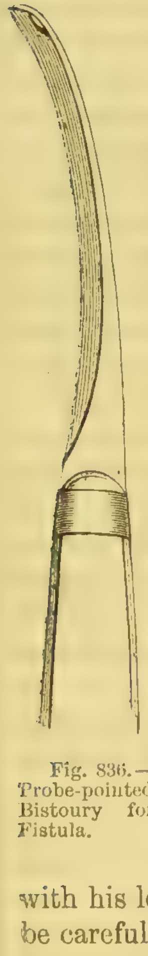


Fig. 836.—Probe-pointed Bistoury for Fistula.

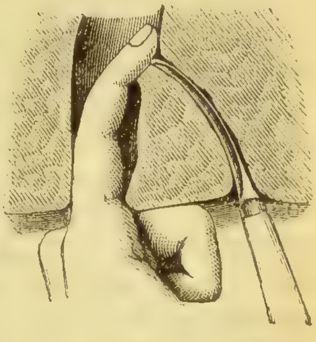


Fig. 837.—Operation for Fistula in Ano.

slit up; and, in those cases in which the course of the fistula runs more or less at a right angle to that of the external sinus, it is necessary to do so before the deep or internal fistula can be reached, through which the sphincter must be divided. If the fistula be a *blind external* one, it must at the time of the operation be made complete, by scratching with the end of the knife through the thinned structures that intervene between its extremity and the interior of the gut; and the operation must then be completed in the way described. The Surgeon must not be too ready to conclude that the fistula has no internal opening, as it is important that it should be laid open if it exists. A long and careful search with a probe should therefore be made in all cases in which an internal aperture is not at once found. If it be a *blind internal* fistula, a speculum should be inserted, and a bent probe passed through the inner opening of the fistula into the canal. The end of this, which can be felt externally, must be exposed by a puncture made through the integuments with a scalpel, and the operation concluded in the ordinary way.

When there is an internal aperture into the gut, this will usually be found just above the sphincter; the fistula, however, may not terminate here, but frequently extends up by the side of the gut for an inch or two. In these circumstances, what should be done with the *cul-de-sac* above the inner aperture? If it be laid open, an extensive and deep wound will be inflicted, which may implicate some of the hæmorrhoidal vessels, and thus give rise to a dangerous amount of bleeding. Hence I think it a safer practice for the Surgeon to content himself with the division of all the parts intervening between the inner aperture of the fistula and the verge of the anus; the sinus which is left usually contracting and closing without difficulty when this has been done. In some cases, however, it happens that this *cul-de-sac* is not readily obliterated, but gives rise to a good deal of trouble in consequence of the occasional accumulation of pus in it, and the thickening of its aperture into the bowel causes spasmodic contraction of the sphincter and a kind of rectal stricture. This inconvenience gradually subsides in most cases, under the use of astringent injections or the introduction of a probe coated with nitrate of silver.

If the integuments around the fistula have been much undermined and thinned so as to leave loose flaps at the edges of the incision, the cure will be materially hastened by cutting these off. The unhealthy granulation-tissue lining the fistula should be scraped away with a sharp spoon and the raw surface cleaned with a sponge moistened with some chloride of zinc (gr. 40 to ℥j), care being taken that this does not touch the healthy skin of the anus. Iodoform should then be freely applied to the raw surface and a piece of iodoform wool inserted, after the introduction of a half-grain morphia suppository. A pad of wool is then put on and a T-bandage applied. This dressing may be left unchanged for three days. The wool can then be removed without difficulty or fear of bleeding. The bowels should be kept confined for three or four days by small doses of opium. After the first dressing the wound may be daily dusted with iodoform and a fresh piece of wool applied to it. It should be well washed at each dressing with a concentrated solution of boracic acid or some other antiseptic. If there is any swelling and pain, lint soaked in a warm solution of boracic acid may be applied externally and covered with oiled silk. Care must be taken to prevent the bridging over of granulations, if necessary by the occasional introduction of a probe. If the wound is slow in healing, red wash must be applied. After the wound has completely united, a notch will usually be left by the side of the anus, which gives rise to some inconvenience for a time by the occasional involuntary discharge of a little intestinal mucus, and some flatus. This happens especially in those cases in which the incision has been made anteriorly to the anus into the perinæum. Should an inconvenient or dangerous amount of hæmorrhage occur at the time of the operation, the wound should be plugged with iodoform wool, and a firm pad applied by means of a T-bandage. Should profuse bleeding, in consequence of the division of some of the hæmorrhoidal vessels, come on a few hours after the operation, all coagula should be cleared away, the gut washed out with ice-cold water, and then securely plugged either with a piece of compressed sponge, or with a lithotomy or œsophagus tube, surrounded by lint soaked in a solution of perchloride of iron, and pushed into the bottom of the sinuses that have been laid open.

HÆMORRHOIDS OR PILES.

By **Hæmorrhoids** or **Piles** is meant a morbid condition of the blood-vessels of the anus and lower part of the rectum, especially of the veins of the submucous or subcutaneous areolar tissue, giving rise to more or less intumescence of the part, which may or may not be attended with a discharge of blood. Surgeons are commonly in the habit of classifying piles, according as they bleed or not, into **Open** or **Blind**; or, according as they spring from above or below the verge of the anus, into **Internal** or **External**; the internal being always within the gut, the external habitually protruding out of or around the anal aperture. The first may either bleed or not; the latter are always blind. To this division into external and internal, B. Cooper added an intermediate variety, the **Intero-External**, which is partly within and partly without the anus. These divisions are of much practical moment, as the treatment is very materially modified according as the hæmorrhoid is situated above or below the anal verge.

Predisposing Causes.—We must look to the peculiar *arrangement of the veins of the rectum* as directly predisposing to the occurrence of piles. The lower part of the rectum and the verge of the anus are composed of a plane of muscular fibre and a muco-cutaneous surface, with an intervening stratum of loose areolar tissue, in which a close interlacement, or net-work, of tortuous veins is situated. The blood, from this plexus of hæmorrhoidal veins, finds its way into the general system through two distinct channels. By far the greater portion of it is carried into the inferior mesenteric vein, and thence into the vena portæ, through the superior hæmorrhoidal vein, which may be looked upon as the extreme radicle of the portal system; and some passes into the internal iliac vein through branches that accompany the middle and inferior hæmorrhoidal arteries. We may, therefore, look upon the hæmorrhoidal plexus as being placed midway between the portal and general venous systems, but as belonging rather to the portal than to the systemic veins. In these arrangements we see all the elements that would predispose to congestion, and consequent dilatation of the vessels of a part. There is a large and intricate plexus of veins in which, as in all similar net-works, there is a tendency for the blood to circulate slowly; the natural tendency to stasis being much increased by the dependent position of the part, and by the absence of valves in the superior hæmorrhoidal vein and in the vessels into which it pours its contents, the whole pressure of the column of blood in the portal system may be brought to bear upon the hæmorrhoidal plexus. The circulation through the portal system is likewise subject to much interference in consequence of hepatic and intestinal obstruction, and in these changes the blood in the hæmorrhoidal plexus also participates; and, were it not for the provision that exists by which this plexus may free itself to a certain extent from over-distension by its communication with the internal iliac through the medium of the middle hæmorrhoidal vein, piles would be much more frequent than they even now are, as a consequence of obstructed portal circulation. Another great cause of hæmorrhoidal enlargement is to be found in the want of support that the veins of this plexus experience on their mucous aspect during defæcation. Situated as they are in areolar tissue, between a plane of muscular fibres on one side, and yielding mucous membrane on the other, when distended by the constriction which they undergo during and after the expulsion of the contents of the rectum, they necessarily give way on that side on which they have the least support, being forced down and elongated, together with the mucous membrane under which they ramify, and which has a natural tendency to become slightly everted during the act of defæcation.

Age exercises considerable influence in predisposing to piles. This disease is not unfrequently met with in young men of eighteen or twenty years of age; more especially if they be of a relaxed and phlegmatic temperament with languid circulation, and be obliged to lead a more sedentary life than is natural or proper at that age. After this period, the liability to the disease diminishes until middle age is reached, when it becomes more marked than at any former period of life, owing to the more active operation of those causes that tend to impede the return of the portal blood.

Sex appears to exercise more influence on the occurrence of hæmorrhoids at particular periods of life, than on the general liability to the disease. It certainly appears to be more frequently met with amongst men at an early age, than in young women; but at a later period of life, so far as my observation goes, the disease occurs with nearly equal frequency in both sexes. The comparative exemption of young women is readily accounted for, by the periodic discharges from the uterus preventing the congestions that might otherwise occur in the parts in its vicinity. The greater frequency in females at a later period of life is attributable not only to the pressure of the gravid uterus on the veins, but also, after the cessation of the menses, to the congestion that is apt to be set up in certain organs of the female economy, and to the retardation of the portal circulation by the accumulation of fat and by other causes; these conditions occur chiefly in women of a plethoric habit.

A sedentary life with indolent habits constitutes, perhaps, the most powerful predisposing cause of the disease; more especially if habitual high living be conjoined with want of exercise. Indeed, the artificial and luxurious habits of the more opulent classes, by diminishing tone at the same time that they occasion plethora and a tendency to abdominal engorgement, exercise a considerable influence on the occurrence of this disease, which is much more frequent amongst them than in persons in the humbler walks of life.

Alcoholic excess is amongst the most common causes of piles, owing to the hepatic congestion it commonly gives rise to. If it be carried to the extent of causing cirrhosis of the liver the condition becomes aggravated. Under these circumstances bleeding piles may serve as a sort of safety-valve to the overloaded portal circulation, and should on no account be interfered with. So important is this that in all cases of piles, before undertaking an operation, the symptoms of cirrhosis—morning vomiting, failure of appetite, intermittent diarrhœa and occasional slight jaundice—should be inquired for.

There are a number of minor conditions which are commonly looked upon as predisposing causes of this disease, though it is extremely difficult to determine the precise share that each has in its production. Amongst these may be mentioned intemperance in food; residence in warm, moist, and relaxing climates; the use of soft and warm beds, or the opposite condition of sitting on a cold stone or damp cushion. Over-excitement of the generative organs also will occasion it.

Exciting Causes.—Amongst the exciting causes may be mentioned *local irritation* of any kind. Thus, in some people hard riding will bring on an attack of piles. The *habitual use of drastic purgatives*, more especially of aloes, rhubarb, &c., is well known to occasion the disease; though it must be observed that individuals, who make habitual use of these remedies, often labour under some of those obstructions of the abdominal viscera that have already been noticed as conducing to piles. The existence of other *diseases about the rectum and anus*, such as fistula, ulcer, or stricture, by inducing local congestion and irritation, may excite the disease; so also, *uterine affections* and various *diseases of the genito-urinary organs* may give rise to this affection.

The most direct exciting cause of piles is certainly a *retardation to the return of the portal blood.* Habitual constipation; the accumulation of hardened fæculent masses in the large intestine; obstruction to the proper action of the liver, and consequent congestion of that organ; the pressure of abdominal tumours, or of the gravid uterus, are all active exciting causes, interfering as they do with the proper return of the blood from the hæmorrhoidal veins. In some cases, even the existence of an obstacle to the circulation in the systemic veins may occasion this disease; thus it will arise from the pressure of an aneurismal tumour on some of the large venous trunks within the chest.

Structure.—A pile, whether external or internal, consists essentially in the first instance of a varicose condition of a portion of the hæmorrhoidal plexus, or rather, of the small veins of the submucous tissue that pour their contents into this; this varicose condition, becoming prominently developed at certain points, gives rise to small knots or tumours. A pile in this state is quite soft and compressible, and can readily be emptied by pressure; and when cut into, it will be found to be composed of one or more spaces filled with blood, and surrounded by areolar tissue. These spaces are formed by the sacculated and dilated veins that enter into the composition of the tumour. After the piles have existed for some little time, or after they have once become inflamed, the tissues that enter into their composition undergo modifications that induce corresponding alterations in the character of the tumour. The coats of the veins become thickened; their cell-like dilatations may be filled with coagulated blood; the investing areolar tissue is hypertrophied or thickened; and, on being cut into, the pile is seen to be composed of a spongy kind of tissue containing much blood. External piles, when examined after removal, often resemble in structure a mass of hypertrophied cutaneous and subcutaneous tissue, in which a number of small vessels of uniform character ramify, but without any appearance of cyst-like spaces. Internal piles, on the contrary, contain more of the venous, and less of the areolar element. They are also commonly furnished with a small central artery, which is apt to bleed freely, or even dangerously, if the tumour be cut across; hence, provided they are not clogged with coagulated blood, they may readily be injected from the inferior mesenteric artery.

In studying the structure of hæmorrhoids, it is of importance to observe that they occur under two different forms: one in which there are distinct tumours, within or external to the anus, and another in which there is merely a varicose condition of the veins of this region, without distinct intumescence.

In those case in which there is merely a general varicose state of the veins of the submucous areolar tissue of the anus, without any distinct tumour springing above the level of the membrane, it will be found that the smaller branches of the hæmorrhoidal plexus, and the small twigs that enter these from the submucous areolar tissue, have undergone varicose dilatation, being apparently greatly increased in number, as well as in size. The mucous membrane is of a deep mulberry or port-wine colour, and becomes everted after each motion. There is usually some mucous secretion about the anus, rendering the part moist: and the patient complains at times of weight and of bearing down, with pains either in the part itself, in the sacro-lumbar region, or in the thighs. The motions, more especially if hard, are streaked with blood, and more or less of this fluid drops in a rapid manner after the passage of the fæces. There is seldom much blood lost; but at times there is an exacerbation of all these symptoms, and the hæmorrhage, as will more particularly be mentioned hereafter, may become very abundant. This condition of the mucous membrane may precede, and is frequently found to accompany the true pile, whether external or internal, and may be looked upon as constituting the first stage of this disease. If this state of things be allowed to continue unrelieved, the tendency to congestion increases; more and more of the mucous membrane is everted and protruded after defæcation; the submucous areolar tissue becomes stretched and lax, and the case is apt to become one of prolapsus ani.

External Hæmorrhoids are those that are situated below the verge of the anus, and that are invested by cutaneous, or, at most, by muco-cutaneous tissue. Before appearing as defined tumours, they usually constitute longitudinal folds that surround the anal aperture, or radiate from it as from a centre; and, their tegumentary covering consisting of the thin skin of the part, they resemble folds of this tissue rather than of mucous membrane. In colour, they vary from that of the natural structures to a pink or purplish hue. Their size varies, according to the state of congestion; and hence the same tumour may at one time be soft, flaccid, and loose, apparently nothing more than a fold of integument, and at another may become tense and tumid.

Symptoms.—When of small size and recent formation, external piles do not in general give rise to much distress, but merely some local heat, pricking, and itching, with a sense of fulness after defæcation; but when of large size, and inflamed or irritated, they may occasion very acute suffering. There is not only deeply-seated, dull, aching and throbbing pain in the pile itself, but this shoots up the side of the rectum, through the perinæum, and into the nates, and is much increased when the patient stands or walks. After a few days these symptoms subside; suppuration either taking place in the pile, or the blood contained in it coagulating. The parts are, however, left in a thickened and indurated state, and do not readily resume their former soft and flaccid condition, inflammatory exudation taking place into the areolar tissue, and the contained blood coagulating, so that the tumour can no longer be emptied by pressure, but assumes the form of a broad, rounded, and indurated mass.

Internal Piles.—When the pile is situated altogether within the verge of the anus, it is called "internal;" of these there are two principal varieties, the *Longitudinal* and the *Globular*.

The **Longitudinal,** or, as it is sometimes called, the **Fleshy** pile, is generally met with about an inch or two up the rectum. It is spongy, elastic, firm, or tough, of a dark reddish or dusky brown tint, tapering upwards from a broad base. It seldom bleeds or varies much in size ; between the piles are found small valves, or folds of mucous membrane, forming pouches, with their concavities looking upwards. These are apt to become distended and pressed downwards by the fæces, especially if the motions be hard and the bowels have been constipated, thus giving rise to a tendency to prolapsus.

When the hæmorrhoid assumes a **Globular** form, it constitutes the ordinary bleeding pile. It may be situated on a broad base ; or, as not unfrequently happens, its point of attachment to the mucous membrane becoming elongated, it assumes a pedunculated shape, hanging downwards into the cavity of the rectum. It is of a dark bluish colour, and numerous small vessels of a brighter hue than the body of the pile may be seen ramifying on the mucous membrane investing it. Its surface is at first smooth and shining, and may continue so throughout, being covered with a thin and delicate prolongation of the lining membrane of the gut. Not, unfrequently, however, superficial ulceration takes place, and then it has a granulated strawberry-like appearance.

Symptoms.—Internal piles are usually attended by a sensation of heat, itching, pricking, or smarting about the anus, and a feeling as if there were a foreign body within the gut. After defæcation these sensations are increased, and are often accompanied by a bearing down, as if the bowel were not emptied of its contents, that is peculiarly distressing and sickening. This is occasioned by the piles, or the relaxed mucous membrane to which they are attached, being protruded during the expulsion of the fæces, and not returning sufficiently quickly, being grasped by the sphincter ani and constricted by it. This feeling of discomfort and bearing down is much increased, if the patient stand or walk much after having had a stool, or if he have a confined state of the bowels. If this state of things be not properly attended to, the symptoms become increased in severity ; the bearing-down sensation amounts to true tenesmus, and the act of defæcation becomes so painful that the patient defers it as long as possible, and then when it does take place, in consequence of the accumulation of the excreta and their indurated character, the suffering is much increased. External piles now usually make their appearance, if they have not existed before ; the mucous membrane of the rectum becomes prolapsed, and an increased secretion of thin mucus takes place from the orifice of the gut, moistening the part and soiling the patient's linen. Irritation in the neighbouring organs is frequently set up ; occasionally to so great an extent as to mask the original complaint, the patient referring his principal pain and discomfort to these sympathetic disturbances. There is often a dull aching fixed pain at the lower part of the lumbar spine, and more frequently opposite the sacrum or the sacro-iliac articulation on either side ;

this is sometimes very severe, perhaps runs down the thigh, or round the groin; irritability of the testicles may come on, or irritation about the neck of the bladder, causing frequent desire to micturate, and increasing the patient's sufferings by the straining that takes place. The general health now suffers; the patient may become emaciated, and the countenance often presents a peculiarly anxious, drawn, and careworn look.

The symptom, however, that first of all and most prominently fixes the patient's attention, is **Hæmorrhage.** This varies greatly in quantity; at first there may merely be a few drops falling after the passage of a motion, or the cylinder of fæces may be stained on one side by a streak or spots of blood, or the bleeding may amount to several ounces or even pints.

The hæmorrhoidal flux is connected with, and in the great majority of cases dependent upon, the existence of distinct hæmorrhoidal tumours. Occasionally, however, it appears to occur when there is no distinct separate tumour projecting above the surface of the membrane; but in these cases there is general intumescence and congestion of the mucous membrane of the lower part of the rectum, from which the blood exudes in drops, or it may even spurt in a distinct jet from the open mouth of a blood-vessel. The bleeding is frequently ushered in by an exacerbation of those symptoms that commonly accompany piles, such as a sensation of fulness, weight, and tension about the parts. But the symptoms that precede its occurrence are often much more imperfectly marked than is usually stated, and are frequently absent altogether.

The discharge of blood may be periodical, especially in women, occurring every month, or at intervals of two, three, or six months; and it may be remittent or intermittent. In these cases, it usually continues from three to six days, increasing up to the third or fourth day, and then lessening.

When moderate in quantity and short in duration, it is often a source of relief to the patient; but if a very large quantity be lost at one time, or if it continue for too long a period, it becomes a source of great debility; more harm is usually done to the patient by its long continuance than by its excessive quantity at any one time. The patient may become much weakened and anæmic; nervous headaches, pallor, palpitations, and syncope may result. In some cases the hæmorrhage is of service in preventing disease of more important parts; it has especially been looked upon as, and doubtless is in many cases, a safeguard from apoplexy, particularly when it occurs as a consequence of cirrhosis of the liver, or in plethoric and corpulent persons who habitually live too highly. But as a rule, the continued loss of blood from piles is undoubtedly injurious.

Hæmorrhage from piles is sometimes vicarious with, and at other times arrests, the menstrual flow. In a case which I attended with Sir A. B. Garrod, the patient had suffered from the hæmorrhoidal flux and piles from the age of puberty. She menstruated for the first time when thirty-seven years old: up to that period the hæmorrhoidal discharge had occurred abundantly at monthly intervals. After the late establishment of the menstrual function, the piles continued to bleed, but less regularly, and she became anæmic, emaciated and debilitated to the last degree. When she was forty-four years of age, I saw her for the first time; the piles, which were very large and vascular, were ligatured, and she made a perfect recovery.

The colour of the blood is most generally florid, as if it came from the small arteries or capillaries of the part rather than from the veins. It would appear that, in consequence of the over-distended and varicose condition of the veins, the onward flow through the arteries and capillaries leading to them is obstructed; and that, in consequence of the accumulated pressure on those vessels, their parietes give way, allowing the florid blood to escape.

Very commonly the internal piles, when brought down, present a somewhat granular surface, in consequence of ulceration having taken place, and the whole surface will be seen to exude blood in drops. In other instances, the blood appears to come from a cavity in one side of the hæmorrhoid, as if rupture had occurred from over-distension at that part.

The hæmorrhoidal flux may be accompanied by, or alternate with, a thin glairy mucous discharge from the rectum and diseased structures; this would appear to be nothing more than excessive secretion from the membrane, in consequence of the irritation set up by the piles; it is seldom in sufficient quantity to produce much annoyance, or to be of much moment to the patient.

Complications.—Piles are not uncommonly complicated with other diseases of the rectum, such as fissures, fistula, or prolapsus. When connected with fissure, the hæmorrhoid often, as Syme has remarked, assumes a peculiar form and appearance, presenting itself as a small red-coloured body, like a pea in size, firm, and seated at the base of the fissure, which it often conceals; to a practised eye, however, the presence of a pile of this peculiar colour and shape is sufficient to indicate the existence of a fissure.

In that form of fistula in which the aperture is near the anus, one or more external piles of small size are often found situated at the orifice of the fistula; and prolapsus rarely, if ever, is met with in adults, without the simultaneous occurrence of piles.

Terminations.—Hæmorrhoidal tumours may terminate by Subsidence, Coagulation, Suppuration, or Sphacelus.

Complete **subsidence** of a pile can take place only when the disease is of recent occurrence. When of long standing, and after it has been exposed to successive attacks of turgescence and inflammation, an external pile never subsides completely; and the areolar tissue and the muco-cutaneous structures, becoming hypertrophied, form elongated pendulous flaps around the margin of the anus.

Coagulation of the contents of the pile is the result of inflammation. When it takes place, the tumour, after more or less acute inflammation, becomes hard, incompressible, permanent in size, and of a purplish or plum colour. The coagulum thus formed may excite suppuration, or may be absorbed, the hypertrophied tissues forming one of the usual anal folds if the pile be external. In some rare instances, the coagula may be calcified and form phleboliths.

Coagulation takes place more frequently in external than in internal piles, owing to their greater liability to inflammation, their exposed situation leading them to be bruised or otherwise injured. When it occurs in internal piles, it most commonly affects those that are of a columnar or longitudinal shape, and least frequently the globular variety.

Suppuration is not an uncommon termination, if acute inflammation have been set up in internal piles, more especially in those that have previously been coagulated. When the abscess is discharged, small coagula escape with its contents, the cavity granulates, and becomes obliterated, and the pile is cured. The pus in other cases may burrow in the sub-mucous tissue, and, by bursting externally, give rise to a fistula in ano.

Sphacelus.—In some cases, when there is much elongation of the mucous membrane from which the pile springs, prolapsus of that membrane and of the piles may take place; and, this being grasped after it has descended by the contraction of the sphincter, the same effect may be produced as if a ligature were applied. The tumour becomes much swollen, hard, livid, and tense; there are much constitutional disturbance and restlessness; but after a few days the part that is constricted sloughs and drops off, and all the symptoms are relieved.

Diagnosis.—The diagnosis must be regarded from two points of view:—1, as concerns the *Hæmorrhoidal Tumours;* and 2, with reference to the *Hæmorrhoidal Flux.*

1. **Hæmorrhoidal Tumours** must be diagnosed from prolapsus ani, polypus of the rectum, epithelioma of the anus, and condylomata about the anus. From **prolapsus** the diagnosis is not always easy; indeed, the two diseases are so generally associated, that it is of little moment to attempt it. In true prolapsus, ocular examination will suffice to distinguish the membranous wall of the intestine, forming a smooth, rounded, and somewhat lobulated annular protuberance, from the isolated tumours of piles. In **polypus** the history of the case, the pedunculated and solitary character of the tumour, its large size, and comparatively slight tendency to periodical hæmorrhage, will enable the Surgeon to make the diagnosis. **Epithelioma** is easily recognized by its hardness and by its deep infiltration of surrounding parts. In any case of doubt, a digital examination of the rectum will make its nature evident. From **condylomata** the diagnosis is easy; the soft, flat, mucous, and wart-like character of these growths, their history, and their occurrence at other points, as the perinæum, scrotum, vulva, and buttocks, will enable the Surgeon to distinguish them without any difficulty.

2. The **Hæmorrhoidal Flux** must be distinguished from other **intestinal hæmorrhages.** This may be done by attention to the character of the blood, which will enable us in many cases to determine its source. When it comes from piles it is liquid, of a more or less florid colour; not unfrequently it is quite bright, staining or coating the fæces rather than being mixed up with them. When, on the contrary, the blood is poured out at some higher point in the intestinal canal than the usual seat of hæmorrhoids, it is of a dark, sooty character, mixed up with liquid fæces either in a diffused form or in small black coagula, and no fresh or bright blood will be visible. Digital exploration of the rectum in cases of piles, and the presence of symptoms indicating the existence of mischief at a higher part of the intestine than the anus in cases of melæna, will also serve to point to the source of the flux.

Treatment.—In conducting the treatment of a case of piles, that Surgeon will succeed best who looks upon the disease not as a local affection, merely requiring manual interference, but as a symptom, or rather an effect, of remote visceral obstruction and disease, the removal of which may alone be sufficient to accomplish the cure, without the necessity of any local interference; or, should it be thought necessary to have recourse to operative procedure, this must be made secondary to the removal of those conditions that have primarily occasioned the congestion and dilatation of the hæmorrhoidal vessels. The treatment of piles, therefore, must be considered, 1, as regards the Removal of these

Constitutional Conditions or Visceral Obstructions that occasion the disease, together with any Topical Applications that may be considered necessary; and 2, with reference to the Operative Procedures that may be required for the removal of the affection.

1. The **Constitutional Management** of piles necessarily varies considerably according to the condition of the patient in whom they occur, and the visceral obstruction to which they may be referable. Thus, when they occur in debilitated persons most benefit will be derived from a mild tonic and nutritious plan, at the same time that the bowels are kept regular by some of the aperients that will immediately be mentioned. In these cases, also, much advantage is often obtained by the administration of the confection of black pepper, which acts as a useful local stimulant to the vessels of the rectum. A small cold water injection after each motion is of the greatest possible service in these cases. In the great majority of instances, however, more particularly when occurring about the middle period of life, piles are connected with a plethoric state of system, and obstruction of the abdominal viscera. In these circumstances, our efforts should be directed to the reduction of the plethoric condition, by putting the patient upon a proper regimen, prohibiting the use of stimulants, and lessening the quantity of animal food. When piles arise from the pressure of a gravid uterus or other abdominal tumour, little can be done; except, by local palliatives and mild aperients, to moderate the inconvenience attending them.

In all cases of piles, but more particularly in those arising from hepatic obstruction, mild aperients are of essential service; by removing fæculent accumulations, and establishing a free secretion from the intestinal surface, they tend materially to prevent congestion of the portal system. At the same time, drastic purgatives of all kinds should carefully be avoided. The most useful aperients are the electuary of senna, sulphur, and castor-oil; one or other of which should be taken regularly twice or thrice a week at bed-time, in as small a quantity as will be sufficient to keep the bowels free. In many cases, the confection of senna may advantageously be given in combination with precipitated sulphur and the bitartrate of potash, equal parts of each of these being made into a mass with twice their quantity of the confection and a little syrup; of this electuary a dessert-spoonful may be taken every night or every second night. In many cases the laxative mineral waters, such as Friedrichshall, Hunyadi-Janos, or Æsculap, taken on rising in the morning, will be found of great use. If there be a relaxed condition of the rectum and anus conjoined with the piles, as not unfrequently happens in old as well as in young people, the administration of an electuary composed of equal parts of the confections of senna and of black pepper, or of cubebs, will be found very useful. In fact, in all cases in which the black pepper is administered, an aperient should be given from time to time, to prevent its accumulation in the large intestine. When the liver is much obstructed, the treatment should be specially directed to the relief of this organ; with this view, a course of Plummer's pill, followed by taraxacum, and, in relaxed constitutions, the mineral acids, will be found especially serviceable, at the same time that the bowels are kept free by gentle aperients.

Tincture of Hamamelis is said materially to relieve, and, in fact, to cure bleeding internal piles. It may be administered by the mouth and by enema simultaneously. The habitual use of clysters, consisting either of soap and water or thin gruel, will be found advantageous in many cases of piles, though in some they appear to irritate, and rather to increase the disease. When the piles occur in relaxed constitutions, the enema should be used cold ; but when the patient is of full habit of body, a tepid one will usually be found to agree best. In the general management of piles, it need scarcely be observed that any habits which favour the disease should be sedulously avoided.

The **Local Treatment** of piles is of considerable importance. The parts should be regularly sponged with cold water, morning and evening. If there be much relaxation, and the piles be internal, benefit may result from the employment of some astringent injection, such as a very weak solution of the sulphate of iron, or of the tincture of the sesquichloride—a grain of the first or ten drops of the second, to an ounce of water ; of this about two ounces may be injected every night and left in the rectum. The application of an astringent ointment, such as the unguentum gallæ co., extract of witch-hazel, or the employment of the anodyne and astringent suppository already recommended for fissure of the anus, will be attended with much benefit.

If external piles become inflamed, the patient should keep his bed, and leeches may be freely applied around but not upon the tumours ; these, however, are seldom required. The pile may be painted with equal parts of extract of belladonna and glycerine, and hot water or poppy fomentations must be assiduously used, a very spare diet enjoined, and the bowels opened by mild saline aperients. If a coagulum form in an external pile, as the result of inflammation, the tumour should be laid open with a lancet, and its contents either squeezed, or turned out with the flat end of a director. If an abscess form, it must be punctured in the usual way, and the part afterwards fomented or dressed with boracic lint soaked in warm boracic lotion. Should strangulation of internal piles take place, the protruded swelling must be returned by gentle steady pressure, and the part afterwards well fomented.

2. **Operation.**—The means above indicated are usually sufficient in ordinary cases of piles ; but if the disease attain an inconvenient size, giving rise to general irritation and local uneasiness, or if the abundance of the hæmorrhage be such as seriously to interfere with the health of the patient, it will become necessary at last to have recourse to operative interference, with the view of removing the diseased structures. No operation should ever be undertaken whilst the pile is in an inflamed state, lest unhealthy inflammation be set up in the part ; it is also well to get the patient's health into a good state, as erysipelas may otherwise follow the operation ; and before proceeding to perform it, care should be taken that the bowels have been well opened by a purgative, and the rectum cleaned by an enema of warm water. If the patient is suffering from cirrhosis of the liver no operation is justifiable.

There are five plans of treatment commonly adopted for the removal of piles ; viz., excision of the tumour, its strangulation by ligature, its destruction by the clamp and cautery, by crushing, and by the use of caustics. These methods of treatment should not be employed indiscriminately. The first alone is applicable to external piles ; the others only to the internal form of the disease.

Excision of External Piles.—The removal of external piles is readily effected. The tumour should be seized with a vulsellum or hook, drawn forwards, and snipped off with a pair of knife-edged scissors, curved upon the flat. At the same time any penduluos flaps of skin in their vicinity should be excised, lest they become irritated, and constitute the basis of a fresh pile. In doing this the scissors must be made to cut in lines radiating from the anus, and too much skin must not be removed lest a strictured anus result. After the excision of external piles the hæmorrhage may readily be arrested by the application of dry iodoform wool, or a pad of lint and T-bandage; should any small artery bleed, it may be pinched or tied. The hæmorrhage attendant on this little operation is sometimes rather profuse.

Ligature.—Internal piles are usually removed by the ligature; in fact, it may be laid down as a rule of surgery, that no internal pile should ever be simply cut off with scissors in the same way as an external pile. The reason of this difference in the practice to be adopted, according as the pile is situated above or below the margin of the anus, is the liability to hæmorrhage in the one case, but not in the other. The bleeding that follows the excision of an external pile is readily arrested, but with internal piles it is different; these tumours are not only more vascular, being often fed by a large central arterial twig, but are deeply seated, and do not readily admit of the application of means for the arrest of the flow of blood from them. So difficult is it to stop the bleeding from an internal pile in some cases, that patients have actually lost their lives from this cause after its excision, even in the hands of some most distinguished Surgeons. The simple excision of internal piles has consequently been very properly abandoned.

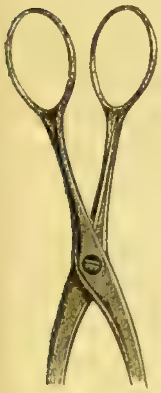


Fig. 838.—Ring Forceps.

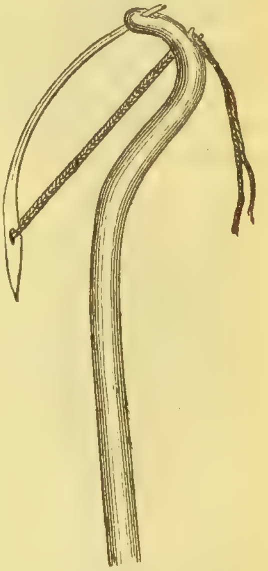


Fig. 839.—Bushe's Needle for applying Ligature to Piles.

The **Operation for the Ligature of Internal Piles** may most conveniently be conducted in the following manner. The patient, having had his bowels cleared out by a dose of castor-oil on the day preceding that fixed for the operation, should have an abundant enema of warm water administered about an hour before the Surgeon arrives; and he should then be directed to sit for half an hour on a bidet, or over a pan containing hot water, bearing down at the same time, so as to cause the piles to protrude. When all is ready, he should be laid on the bed on his left side, with the nates well projecting; the Surgeon then seizes the most prominent pile with a ring-forceps (Fig. 838) provided with catch handles, draws it well forwards, and ties its base as tightly as possible with a thin whipcord ligature, which may previously have been rendered more or less antiseptic by soaking it in a concentrated solution of iodoform in ether, and then drying it. One pile after the other is tied in the same way, until all that can be met with have been strangulated. In some cases the pile is so broad at the base, that the ligature will not include it. In such cases some Surgeons employ transfixion; this may usually be done readily enough by means of a nævus-needle, or by the instrument represented in the annexed drawing (Fig. 839), Bushe's Needle, which consists of a steel shank fixed in an ivory handle, and having its free end perforated for the reception of a needle-eye near its point. In this instrument not only is the angle formed by the needle and the shank a very convenient one for passing a ligature through a pile inside the anus, but more particularly, as the needle can be detached, it may, as soon as it is carried across the base of the tumour, be separated and so withdrawn more readily than it otherwise could. Transfixion of the pile and its ligature in two halves is, however, a very dangerous procedure, and should never be had recourse to if it can possibly be avoided. The danger consists in the possibility of a hæmorrhoidal vein being transfixed, and the two halves then tied separately. In this way the vessel is left open and cannot collapse, and the risk of direct septic absorption becomes very great.

Transfixion may usually be avoided when the pile is large and round, by snipping through the cutaneous portion by means of curved scissors, thus leaving a deep groove for the reception of the ligature, which then constricts only the substance and mucous surface of the hæmorrhoid. If the pile be longitudinal, it may be deeply notched with scissors in a direction upwards from its lower attachment, at the line of junction between the skin and mucous membrane, and the ligature tied in the groove thus formed. In whatever way the ligatures are applied, care should be taken that they are tied as tightly as possible, so that the piles may be effectually strangled at once ; as in this way they separate much more readily, and with far less pain to the patient than if loosely tied. When all the tumours requiring ligature have been tied, the superficial part of each strangulated pile may be cut off with scissors, and the stump carefully touched with chloride of zinc lotion (gr. 40 to ℥j), care being taken to avoid the surrounding mucous membrane. Iodoform in crystal may then be well rubbed into the raw surface. The ends of the threads must then be cut off close, and the strangulated mass pushed back into the bowel. If there be any external piles, these must now be cut off ; for, unless this be done, they become irritated, swollen, and inflamed by the presence of the ligatures, and constitute a source of much distress. A morphia suppository is administered and the patient must now return to bed, and should keep the recumbent posture until the ligatures separate, which usually happens from the sixth to the eighth day, when an ulcerated surface will be left, which, however, speedily contracts and closes. In some cases this process may be facilitated by the application of the nitrate of silver through a speculum ani. On the sixth or seventh day after the operation, the bowels may be opened with a dose of castor-oil ; until then they should be kept from acting by proper diet and small doses of opium.

In the *after-treatment* of the case, care must be taken to prevent the recurrence of those causes that gave rise to the affection in the first instance. After piles have been tied, more particularly if they be seated towards the anterior part of the rectum, there is frequently great irritation set up about the neck of the bladder, so that the patient experiences difficulty in passing his urine, and sometimes suffers from complete retention ; a full dose of hyoscyamus and nitrous ether, will sometimes relieve this, but if it fails, a catheter must be passed. In some cases, where the external piles are very large and vascular, and the patient debilitated, the ordinary rule of cutting them off may advantageously be deviated from, and a combination of the treatment by excision and ligature be adopted. In such cases an incision may be made through the integuments merely, and then the piles tied in the course of the groove thus formed. By these means the pain and constitutional disturbance consequent on the inclusion of a portion of the integument in the ligature are avoided, at the same time that the risk of hæmorrhage is not incurred.

The treatment of piles by ligature is not altogether devoid of danger in persons of broken constitution. I have more than once known death from pyæmia result in these cases. The application of chloride of zinc and iodoform as above described is all we can do to lessen this danger.

Smith's Operation.—Piles may be removed with but little fear of hæmorrhage by the method introduced by H. Smith, which is as follows. The pile is brought down and seized in a clamp (Fig. 840), fixed by a few turns of the screw, and burnt off with a cautery. The clamp is then slowly relaxed, and should any bleeding take place as it becomes loose, it is again tightened, and the cautery applied once more. The operation is usually followed by less pain than the ligature, and is followed by equally satisfactory results; hæmorrhage is prevented, and cicatrization facilitated.

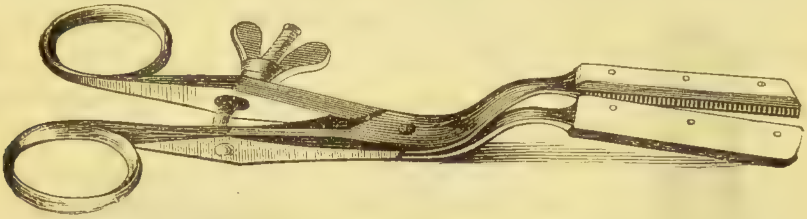


Fig. 840.—Smith's Clamp.

The Removal of Piles by the Galvanic Ecraseur may easily be effected, the pile being drawn down with ring-forceps, and its base constricted by the platinum-wire of the écraseur, which, being tightened, cuts off the projecting mass very readily. This treatment is, however, more troublesome, and presents no advantages over the method by the clamp and cautery.

Crushing.—The plan of removing piles by crushing has been introduced by Pollock. By this method the hæmorrhoid, after having been properly freed by snipping with scissors, is seized in a pair of screw-forceps, which are tightened so as to compress the pile into a narrow line at the part seized—the projecting portion is then cut off and the instrument removed. Allingham has invented a clamp (Fig. 841) for this purpose, which is more powerful than the forceps and very easy of management.

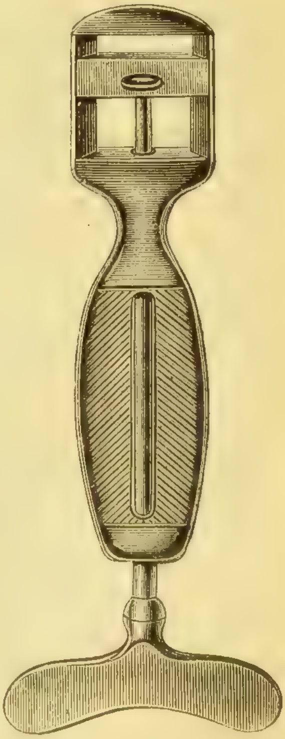


Fig. 841.—Allingham's Clamp.

Caustics.—In certain kinds of internal piles, the application of nitric acid has been recommended by Houston of Dublin, and H. Lee, and may certainly be adopted with advantage. It must not, however, be applied to the external or to the intero-external pile, as it will produce extreme irritation; nor can it be looked upon as a substitute for other means in internal piles generally. It is especially in the granular pile, having an ulcerated surface, that this mode of treatment is useful; as in these cases it appears, by destroying a portion of the mucous membrane, not only to cure the pile to which it is applied, but, by producing an ulcer, to give rise to a cicatrix, which, by contracting, consolidates the parts in its vicinity, and so lessens the relaxed state of the rectum, which favours the hæmorrhoidal tendency. The acid may conveniently be applied through a glass speculum, having an aperture on one side (Fig. 842). This should be introduced well oiled, until the pile projects through the opening in it, when it must be freely rubbed with a piece of stick, or a glass rod, or brush, dipped in the acid; the surface is then immediately wiped with a piece of lint saturated with prepared chalk and water, and the instrument removed. Or the gilt clip (Fig. 843) may be used, so as effectually to protect the neighbouring parts from the action of the acid. A thin slough separates, leaving a raw surface, which gradually cicatrizes and contracts. The application of the acid occasions but little pain when fairly made within the rectum; but if a drop of it accidentally come into contact with the muco-cutaneous surface, a vast deal of irritation and inflammation is excited. This plan of treatment, though useful in particular forms of pile, as when the tumour is granular and flat, so as not to allow of ready removal by the ligature, should not be practised when other means can be employed, as it is by no means so certain a mode of treatment. It cannot be considered altogether devoid of risk; for I have known one instance in which fatal erysipelas followed the cauterization of piles with nitric acid.

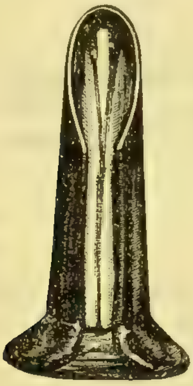


Fig. 842.—Speculum Ani.

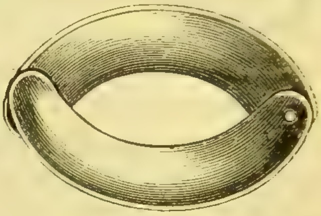


Fig. 843.—Gilt Clip.

Whitehead's Operation by Excision.—In 1876 W. Whitehead of Manchester revived the abandoned operation of excision with so many modifications as to make it altogether a new proceeding. He contends that internal piles are never to be regarded as distinct localised tumours, amenable to individual treatment, but are component parts of a diseased condition of the entire plexus of veins of the lower end of the rectum, and that to effect a permanent cure the whole of the affected mucous membrane with the diseased veins should be removed. He was led to this conclusion partly by observing the frequency of relapses after operations by the ligature or caustics. He maintains that by his method of operating, the objections to the old method of excision are done away with, as all bleeding vessels are secured during the operation, and no raw surface is left in the bowel to heal. The operation is thus performed. The patient is placed in the lithotomy position, and the sphincter is then thoroughly paralysed by digital stretching, so that the hæmorrhoids may prolapse without impediment. By the use of scissors and dissecting forceps the mucous membrane is divided at its junction with the skin round the entire circumference of the bowel, every irregularity of the skin being carefully followed, encroaching rather on the mucous membrane than on the skin. By a process of rapid dissection with a blunt instrument, such as the closed scissors, aided by successive snips where necessary, the mucous membrane and attached hæmorrhoids are separated from the submucous bed on which they rested and are pulled bodily down, the hæmorrhoids being brought below the margin of the skin. During this part of the operation it is very important to keep close to the mucous membrane. The bleeding is free but is easily controlled, each vessel being seized in forcipressure forceps and twisted as it is cut. The raw surface may then be carefully cleaned and dusted lightly with iodoform. The next step in the operation is to divide the mucous membrane transversely above the piles. This must be done gradually, commencing below and doing the anterior part last, and after each cut with the scissors the divided part of the mucous membrane must be attached by silk stitches to the corresponding part of the cut edge of the skin of the anus. If the whole circumference of the gut were divided at once the mucous membrane would retract, and great difficulty might be found in bringing it down again. When the complete ring of mucous membrane has been attached to the skin of the anus, a suppository of two grains of belladonna is introduced, the area of the wound is again dusted with iodoform and a piece of oiled lint applied externally and a bandage. In highly neurotic patients Whitehead keeps a bag of ice in close proximity with the rectum for the first few days. He opens the bowels by a dose of castor-oil on the fourth day, and allows the patient to sit up on the same day. Healing almost invariably takes place by first intention, and is complete by the tenth day, the patient returning to work in two weeks. Retention of urine is an occasional complication as in all other operations in this region. Whitehead had in 1887 performed this operation in 300 cases without a single failure or a single serious complication of any kind. He knew of no case of relapse, and none of strictured anus.

Dangers attending Operations for Piles.—The operation for the removal of piles may be attended by three sources of danger. After excision, and even the application of the ligature or of nitric acid, erysipelas may develop. If the objectionable practice of transfixing the pile by the needle be followed, and it be tied in two separate parts, a hæmorrhoidal vein may thus be opened, and its sides held apart by the action of the ligatures, and thus a tendency to direct pyæmic infection be induced ; and lastly, I have seen a kind of erysipelatous colitis follow the operation, leading to profuse muco-purulent discharge and high fever. I have also in one case seen pelvic cellulitis set up. But all these various secondary affections are happily of rare occurrence.

A permanently **moist condition of the skin around the anus** is not unfrequent, as the result of portal congestion or a hæmorrhoidal tendency. It is best removed by the habitual use of aperient salines, or of aperient mineral waters, as those of Pullna or Friedrichshall.

Pruritus Ani is often an extremely troublesome affection, the itching and general irritation about the anus being almost unbearable. In some cases it is due to the presence of external piles or worms. In others it results from the irritation of the skin from the mucous discharge just mentioned. In others again it is due to eczema. Excess in alcoholic stimulants, habitual constipation, and other conditions may give rise to it; but frequently the most careful investigation fails to detect any cause. The *Treatment* must have reference to the cause if one can be found. If there be an external pile, the removal of it; if worms, their expulsion will probably cure the condition. If it is due to eczema, boracic acid ointment with a drachm of extract of belladonna added to each ounce will frequently bring about a speedy cure. If there is a mucous discharge the frequent application of boracic acid lotion may give relief. In some cases it seems dependent on gout, and the treatment for that disease removes the pruritus. In other cases arsenical preparations will be found useful, together with the local application of chlorinated lotions or those containing hydrocyanic acid. Sometimes tar applied by means of a piece of oakum gives complete relief, but in many cases nothing succeeds.

PROLAPSUS ANI.

Prolapsus Ani consists in a protrusion of the mucous membrane of the rectum through the anal orifice; the areolar tissue that lies underneath it being also, in the majority of instances, much thickened and elongated. In the ordinary prolapsus, the muscular structures of the gut are not protruded; yet occasionally the muscular coat descends with the mucous membrane, an invagination of the bowel taking place, which constitutes a far more serious condition. The former condition alone is correctly termed prolapsus ani, the latter is more correctly spoken of as prolapsus or procidentia recti. Prolapsus recti is rarely met with in adults, and is in them never extensive; in children it is the common condition, true prolapsus ani being very rare. The prolapsus of children is, therefore, better considered separately from that of adults.

Causes of Prolapsus Ani.—In weakly persons generally there is a natural tendency to prolapsus; the slight protrusion of the mucous membrane which takes place during defæcation being increased by any constitutional condition that gives rise to atony of the muscular system, especially if irritation of the intestinal mucous membrane be conjoined with this, as in dysentery, chronic diarrhœa, &c. So, again, the habitual constipation, often occurring in persons of a relaxed habit of body, apparently proceeding from want of power in the rectum to expel its contents, and requiring constant straining at stool, predisposes to this affection. It is especially common in those who labour under stricture, stone, or any other disease about the urinary organs that requires a considerable effort to be made in expelling the contents of the bladder. In persons whose constitution has been relaxed by a long residence in India, this disease also frequently occurs. In other cases, and indeed most usually, the prolapsus is associated with piles, the weight and dragging of the hæmorrhoids drawing down the mucous membrane. This is especially apt to happen, when there is a general hæmorrhoidal tendency about the anus. In fact, the causes of prolapsus may be summed up thus: 1. Simple relaxation of tissue, such as is met with in weakly persons; 2. Sympathetic irritation, as in chronic tenesmus, stone in the bladder, &c.; 3. A hæmorrhoidal or polypoid condition of the mucous membrane of the rectum.

Diagnosis.—Prolapsus consists in the protrusion of a ring of mucous membrane of a red or purplish colour, and having a somewhat turgid look, rather lobulated in shape, and varying in size from half a walnut to a small orange (Fig. 844). The mucous membrane covering this ring will be found to be continuous with that investing the sphincter, and this constitutes the mark of distinction between ordinary prolapsus, and a projecting intussusception or a protruding polypoid growth. In prolapsus there is, when the protrusion is down, a dragging and smarting sensation, often attended with a good deal of spasm about the neck of the bladder. In chronic cases, the anal aperture appears to be permanently relaxed ; and, on introducing the finger into it, it is found to be widened and weakened. The folds of skin in its neighbourhood are relaxed and elongated, radiating from it as from a centre ; they are commonly bluish, soft, somewhat swollen, and pendulous, and often the seat of a good deal of irritation. The protrusion at first occurs only after defæcation, and then readily goes back of itself, or is reduced by steady pressure upon it ; after a time, however, it will come down at other periods ; thus it may protrude during riding, walking, or even standing, and is returned with much difficulty.

Strangulation of the prolapsus may occasionally occur, if it be allowed to protrude for a considerable length of time without a proper attempt being made to push it back. It then becomes swollen and livid, with great pain and tenesmus, discharges a fetid ill-conditioned pus, and may eventually fall into a sloughy state, and thus separating, undergo a spontaneous cure.

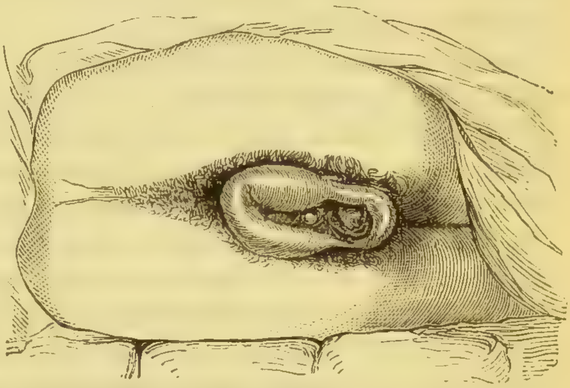


Fig. 844.—Prolapsus Ani.

There is a form of prolapsus that arises from complete atony of the levator and sphincter ani muscles. For this nothing can advantageously be done by operation. Palliation by simple support is the sole treatment.

Treatment.—The treatment of prolapsus may be said to be palliative and curative. The **Palliative Treatment** consists in the first place in reducing the tumour when protruded. This, in ordinary circumstances, the patient does for himself ; but, if it become congested, it requires the help of the Surgeon to put it back. This may occasionally be readily done by making the patient lie on his side or lean over the back of a chair ; and then greasing the mass with some oil, seizing it with a soft towel, and gradually compressing it, working it back. It may be kept up by wearing a belt with a pad and elastic support. Olive-shaped pewter pessaries are occasionally employed, with the view of preventing the protrusion ; but I have never seen them of any service, the sphincter being usually too relaxed to keep them up, and their pressure appearing to excite irritation.

The regulation of the bowels is as important in prolapsus as in piles. It is usually best done by the administration of those laxatives that have been recommended for the latter disease. It is a good plan in prolapsus to get the patient to have his daily motion at bed-time instead of at the usual hour in the morning ; the recumbent position and the uniform temperature of the bed preventing the irritation of the sphincter and spasm of the anal muscles that commonly continue for some time after the reduction of the prolapsus, and which are a source of great discomfort when occurring in the early part of the day.

Curative Treatment.—The relaxation of the mucous membrane of the rectum that essentially constitutes prolapsus may often be obviated by astringent injections or suppositories. The best injection is that of the sulphate of iron, in the strength of from one to three grains in an ounce of water, thrown up in small quantities sufficient for the bowel to retain. In mild cases of prolapsus, conjoined with a relaxed state of the mucous membrane of the rectum and relaxation of the sphincter, the use of the iron injection will be found particularly beneficial, at the same time that the action of the bowels is regulated by means of an electuary taken in the morning or at night. By thus giving tone to the bowel, at the same time that constipation is prevented, the disease will occasionally undergo a cure, provided it be not associated with any affection in other organs.

In those cases in which the prolapsus is hæmorrhoidal or polypoid, the protrusion being dragged down by the weight and strain of the pile or polypus, the same treatment must be adopted as has been recommended for the latter disease ; and usually, after the ligature and removal of the pile or polypus, the prolapsus will be cured. In slight cases of prolapsus, in which the disease appears rather to be owing to the relaxation of the sphincter and of the tissues external to it, the muco-cutaneous integument hanging in loose folds around the anus, considerable benefit will commonly result from snipping off these pendulous flaps of skin ; the cut surface that is left cicatrizing, and by its contraction bracing up the part, and thus preventing its further protrusion. These pendulous flaps are best removed with curved knife-edged scissors in a direction radiating from the anal orifice.

When the prolapsus is considerable, and the ordinary palliative treatment after a proper trial fails in effecting a cure, it will be necessary to remove the protruded mucous membrane by operation. This may be done by the application of the ligature, or by the clamp and cautery. Whitehead's operation is well suited to these cases.

Application of Ligature.—The patient should be prepared in the same way as for the operation for piles (p. 946). If the prolapsus is not protruding it can readily be made to do so by dilating the anus with the fingers. A portion of the protruding bowel may then be seized with a pair of broad-ended forceps, such as are represented in Fig. 838, drawn well forwards and firmly tied with a strong piece of whip-cord. A similar process is then repeated on the opposite side of the anus. Should there be any difficulty on account of the shape of the protrusion in ligaturing the base firmly, this may be obviated by transfixing it with a hæmorrhoidal needle, and tying it on each side. I think, however, that it is better, if possible, to avoid doing this. If the protrusion be very large the ligatures should not be made to include too much, lest the muscular coat, or perhaps even the serous, have also descended, and should be accidentally included, or lest a stricture of the bowel should follow the operation. The ends of the ligature must then be cut short, the whole protrusion returned into the bowel, the external flaps of skin cut off, and a morphia suppository introduced into the bowel. The after-treatment is the same as in ligature of piles. This operation always effects a permanent cure.

The operation by the clamp and cautery and Whitehead's operation are performed in the same way as for piles.

Should a prolapsus become strangulated, it would be necessary to try to reduce it through the sphincter by the employment of the taxis ; if this cannot readily be accomplished, free incisions may be made into it ; if it be not reduced, it will slough away, and thus undergo permanent cure.

Prolapsus of the Rectum.—As before stated this is rare in adults and is seldom extensive. It can only be suspected when the amount extruded from the anus is very large. In children, on the other hand, a prolapsus almost invariably includes the whole of the coats of the bowel. It presents a smooth red surface and projects usually for some distance from the anus. As much as six or seven inches have been known to be extruded. It has before been pointed out that intussusception commencing at the ileo-cæcal valve may reach the anus and actually project from it. In this condition the valve itself forms the apex of the protrusion. If the intussusception occur in the rectum it may still more readily project from the anus. These conditions are easily distinguished from prolapsus of the rectum, for in the latter condition the mucous membrane covering the protruded gut is continuous with the skin at the margin of the anus, while in an intussusception the finger can be passed into the bowel by the side of the projecting invagination. Prolapsus of the rectum is seldom much swollen and very rarely becomes strangulated.

The **Causes** of prolapsus of the rectum in children are various. It is common in connection with dysenteric diarrhœa, especially in weakly children. The irritation of worms is one of the most frequent causes. Polypus of the rectum is an occasional cause, and is easily recognized by the protrusion of the tumour with the bowel. Stone in the bladder is most frequently accompanied in children by some protrusion of the bowel during the straining to pass water. On the other hand an extensive prolapsus may cause irritation of the bladder in a male child and thus simulate stone.

Treatment.—As the protrusion consists of the whole bowel, it is evident that any operative interference would be accompanied by a wound of the peritoneum, and is consequently not advisable. Superficial cauterization and removal of pieces of mucous membrane have been recommended, but they are never necessary. In the vast majority of cases the tendency to prolapsus speedily disappears if the cause be removed. Tonic medicines, especially iron, regulation of the bowels by mild aperients and the administration of a moderate quantity of unstimulating food will soon relieve it if due merely to weakness. If worms are present salt and water or quassia injections will soon get rid of them. If there is any urinary disturbance the child should be sounded for stone, the removal of which will at once cure the prolapsus. The prolapsed bowel should in all cases be bathed with cold water and then reduced by gentle pressure with some oiled rag. A pad supported by a T-bandage will often aid in preventing the descent of the bowel. Should it become strangulated, a condition of extreme rarity, an attempt must be made to reduce it by pressure, but if this fails it must be allowed to slough off, while opium is administered to relieve pain and arrest any action of the bowels. In this way it may safely separate without the occurrence of peritonitis.

Protrusion of an Ovarian Cyst from the Anus occurred in a unique case recorded by Stocks of Salford. The cyst, which was the size of a cocoanut, was removed by incision through the coats of the bowel, which were forced out before the tumour ; and after the wound had healed, the gut was returned.

DISEASES OF THE GENITO-URINARY ORGANS.

CHAPTER LXVI.

SECONDARY DISEASES OF THE URINARY ORGANS ARISING FROM SURGICAL CAUSES. -PYÆMIA AND SEPTICÆMIA IN URINARY DISEASES.

THE great majority of cases of stone in the bladder, stricture of the urethra, cystitis secondary to paralysis, retention from enlarged prostate, tumours of the bladder, and, in short, of every disease tending to hinder the escape of urine from the bladder, or to induce chronic inflammation of that organ, terminate, if not relieved, by giving rise to fatal disease of the kidneys This fact alone is sufficient to make the study of the secondary affections of the kidney of the greatest importance to the Surgeon ; and the obscurity which surrounds their diagnosis, and the general impotence of treatment intended for their relief, render the subject worthy of the fullest investigation.

Morbid Conditions of the Bladder.—If we examine a case in which death has occurred from one of the above-named diseases, we find that the mucous membrane of the bladder shows signs of both recent and old *inflammation.* The recent is indicated by the swollen and softened condition of the mucous membrane, and the intense purple of the summits of the rugæ, and possibly by patches of ulceration, the ulcerated surfaces being often covered by a thick slough closely resembling a diphtheritic membrane. The old inflammation is indicated by the dark slate-grey pigmentation which affects the greater part of the mucous membrane, and which has resulted from repeated attacks of intense congestion, in which red blood-corpuscles have become extravasated. and, after breaking up and becoming absorbed, have left their pigment behind them. The muscular wall of the bladder is found to be *hypertrophied*, or not, according to circumstances. If, in order to expel the urine, it have been called upon to make a greatly increased pressure on its contents, the hypertrophy will be very marked. If the obstruction to the flow of urine have been of a valvular nature, as is often the case in enlarged prostate, then *dilatation* of the bladder will greatly exceed the hypertrophy of the muscular walls. It may, therefore, always be supposed, when great hypertrophy with contraction of the bladder is found, that increased difficulty existed in expelling the urine, but the increased power of the bladder proved equal to the occasion. When dilatation is found combined with hypertrophy, we must conclude that increased power was required to expel the urine, but the increase of muscular tissue was not quite sufficient, and that the bladder suffered frequently from over-distension. When dilatation alone is found with scarcely any hypertrophy, we know either that the bladder has been paralysed or atonic, or that the obstruction to the exit of urine was valvular in nature, so that increased force applied to the contents of the bladder could only shut the valve more closely ; and over-distension, with such an amount of stretching of the neck as to render the valve incompetent, was the only means by which urine could be passed without artificial aid. This last condition is peculiar to prostatic disease, and some cases of tumour of the bladder. In all cases of great hypertrophy, the bundles of muscular fibres form ridges on the surface, giving rise to the condition known as *fasciculation.* In many cases in which great pressure has frequently existed in the bladder, either from the forcible contraction of its hypertrophied walls on the contained urine, or from simple over-distension from retention arising from a valvular obstruction in the prostate, the mucous membrane becomes thrust between the bundles of muscular fibres, so forming pouches called *sacculi.* These sacculi are most frequent in the posterior part of the bladder, and, in most cases, their walls are composed merely of mucous membrane and peritoneum. Sometimes, however, a layer of muscular fibres is also found. These sacculi form pouches in which putrid urine accumulates and frequently gives rise to inflammation of the mucous membrane, sometimes ending in ulceration, and possibly perforation of the bladder. Much more often it gives rise to attacks of local peritonitis, and portions of intestine may thus become adherent to the bladder.

The *causes* which give rise to an increased demand for force in expulsion of the urine, and consequently to hypertrophy of the bladder, are various. The most common is perhaps obstruction in the urethra from stricture. In some cases it may arise from an irregular enlargement of the prostate in which the obstruction is not valvular in character. Villous growth and other tumours of the bladder may call for increased force, from partially obstructing the orifice of the urethra. Chronic cystitis, from the alteration it produces in the character of the urine, always causes more or less hypertrophy. Stone in the bladder causes obstruction to the flow of urine, partly mechanically and partly by the chronic cystitis to which it usually gives rise. The thick ropy mucus of chronic cystitis undoubtedly offers very considerable obstruction to the flow of urine. All these causes, therefore, may give rise to more or less hypertrophy. There is no evidence that mere frequency of action plays any important part in the production of hypertrophy. In the few recorded cases in which there was great frequency of micturition with healthy urine in cases of calculous or tubercular pyelitis, no mention is made of any marked hypertrophy.

There is every reason to believe that hypertrophy of the bladder plays a very important part in the production of kidney disease. In no case, as the result of obstruction to the exit of urine from the bladder, do we find the valves of the ureters incompetent. In the simple dilatation from valvular obstruction in the prostate, they are closed more firmly than natural. No regurgitation takes place, but of course the pressure in the ureters and kidneys will be increased, while the bladder is over-distended. In hypertrophy of the walls, we find also a certain amount of obstruction to the entrance of urine into the bladder, as the ureter has to pass obliquely through the thickened wall, and is doubtless often pressed on by thickened bands of fibres. The swelling of the mucous membrane at the orifice of the ureter in an inflamed bladder probably adds to this obstruction. Here then, although there may be no over-distension of the bladder, there is increased pressure in the ureters and kidneys, the force of secretion remaining unaltered while obstruction to the onward flow is offered by the narrowed orifices of the ureters. The degree of obstruction offered by a hypertrophied bladder varies much, as it is not uncommon to find considerable thickening of the wall of the bladder without any marked signs of pressure in the ureters or kidneys. In cases of villous tumour of the bladder, one ureter and kidney only may be found to be affected, and it will then be seen that the growth implicates the orifice of that ureter. In others, both sides may be equally affected, and both orifices healthy, but it will then be found that the growth has obstructed the neck of the bladder, and that the signs of pressure in the ureters and kidneys are due to hypertrophy or over-distension of the bladder.

Diseased Conditions of the Ureters and Pelvis of the Kidney.—In such cases as we have been considering, three chief forms are met with: 1. The results of simple over-distension without acute inflammation: 2. Acute inflammation without signs of over-distension: 3. A combination of the two. Simple chronic over-distension leads to dilatation of the ureter and pelvis of the kidney, with some thickening of their walls. The thickening is in part due to hypertrophy of the muscular coat of the ureter, and in part to fibroid overgrowth of the submucous tissue. The mucous membrane is of an opaque white colour, and free from pigmentation or ulceration. At the same time that the ureter becomes dilated, it is often increased somewhat in length, and is more or less tortuous, and not unfrequently irregular pouch-like dilatations occur. The dilatation is sometimes so great that the ureter resembles a piece of small intestine. In inflammation of the ureter and of the pelvis of the kidney, we find the mucous membrane swollen and softened, of an intense red colour, and frequently showing patches of a slate-grey, resulting from previous attacks, as in the bladder. Ulceration is not uncommon, and often the ulcers are coated with a tenacious slough like a diphtheritic membrane. The urine contained in such a ureter and pelvis is often ammoniacal and abominably fœtid, and mixed with much pus and mucus. There is every reason to believe that this is a consequence of extension of decomposition from the urine in the bladder to that in the ureter. The severity and acuteness of the inflammation in the ureter are probably due to the irritation of this foul and decomposing urine. But it by no means follows, because the urine in the bladder is decomposing, that the same condition extends up the ureter. In the great majority of cases, the extension of decomposition to the pelvis occurs late in the disease, and acts as the final cause of death, by exciting acute inflammation in the kidney. This extension does not take place on account of any incompetence of the valves or regurgitation of urine, as, on testing the valves in such cases they will be found to be competent. It probably creeps through the orifice of the ureter, by means of the tenacious mucus secreted from the pelvis and ureter, irritated by over-distension. This adheres to the mucous surface and forms a stagnant layer in which decomposition may extend upwards. If after washing out a bladder with Condy's fluid, or some other antiseptic, the first urine that enters from the ureters and flows from the catheter be ammoniacal, the condition of the patient is always serious, as the decomposition has spread from the bladder to the pelvis of the kidney, where no local means can reach it.

Morbid Conditions of the Kidney.—The conditions found in the kidney itself vary considerably. They may be divided as follows: 1. Changes resulting from pressure by obstruction to the entrance of urine into the bladder: 2. Acute interstitial inflammation: 3. Acute interstitial inflammation with scattered abscesses : 4. The results of former acute or subacute attacks from which the patient has recovered.

1. **The Results of Pressure.**—A case lately occurred at University College Hospital, which afforded an opportunity of examining the uncomplicated effects of pressure with great advantage. The ureters had been pressed upon by two enormous sacculi, which projected from the bladder immediately behind the trigone. The bladder was much dilated and hypertrophied, but the cause of disease was uncertain. There were no signs of old or recent cystitis, and no instrument had been passed during life. In this case both ureters were greatly dilated, and the pelvis on each side was expanded so as to contain many ounces of fluid. The kidneys were somewhat increased in size, and before being opened felt like great thick-walled bags of fluid giving all over a distinct sense of fluctuation. On being cut open, each presented the following appearances. The capsule was tough and opaque, and separated with difficulty from the kidney-substance, slightly tearing it in so doing, and leaving the surface coarse and irregular. The surface was uniformly pale, and whitish in colour. No trace of the pyramids was to be seen, but where each should have been was a deep hollow lined with a smooth membrane continuous with that lining the pelvis of the kidney. The cortex was of about normal thickness, but in some parts thinner than natural ; it was somewhat tough in consistence, and presented a uniform opaque whitish tint. The whole kidney was thus converted into a great sacculated bag, composed on one side of the dilated and thickened pelvis, and on the other of the expanded cortex. There were no signs of past or present acute inflammation. On microscopic examination of a section of the cortex, the chief change noticeable was an abundant small round-celled infiltration of the intertubular tissue of the kidney. Every tubule was separated from its neighbours by rapidly growing young connective tissue, crowded with small round cells, and this, by pressing on the vessels, had given rise to the pale colour above noted. The new growth was most abundant round the Malpighian bodies, the capsules of which were greatly thickened ; so much so, that in many the vessels had been strangled and obliterated. The amount of change was not uniform, the new growth being more abundant in some parts than in others. The tubules themselves showed no great signs of change. They were slightly dilated in some parts, and the epithelium looked as if flattened by pressure, but in other respects it was perfectly healthy. This case shows that uncomplicated tension from partial obstruction of the ureter gives rise to a gradual absorption of the pyramids, and to a condition of interstitial inflammation of the kidney, probably varying in severity with the degree and acuteness of the obstruction. In more extreme cases than that above described, the atrophy of the cortex becomes much more advanced, till nothing may be left but a layer of kidney-substance not thicker than a shilling. It is interesting to note, that in the case above described the secretion of urine was abundant, its specific gravity was 1009, and it was free from albumen and casts. It is also evident that, if such a kidney as this were exposed to any additional source of irritation, more acute inflammation incompatible with life would readily be set up.

2. **Acute Diffuse Interstitial Inflammation.**—In this condition the kidney is soft and swollen. The capsule is opaque, and small vessels are seen ramifying in it. It separates easily, but tears the kidney-substance in so doing. The surface of the kidney is coarse and irregular. The colour of the surface is

mottled, the greater part being usually of a pale yellowish tint intermixed with purple patches. Sometimes the mottling is very fine, almost granular. The venous stars always seen on the surface of the kidney are injected, and show out prominently. On section, the cortex is found to be abnormally soft, and to present the same mottled colour as the surface. Sometimes the part of the cortex corresponding to one pyramid may present a more uniformly pale appearance than that belonging to another. Small yellowish spots, looking like minute collections of pus, may be present, which are, however, on section found to be solid, though very soft. The pyramids are usually intensely injected, and contrast strongly with the paler cortex. Pale streaks can often be seen running parallel to the straight tubules. These are most frequent in those cases in which the pelvis is filled with putrid urine. The pelvis is found in some cases free from any signs of acute inflammation, though more frequently it is much affected and filled with foul urine and mucus. The appearances here described are often conjoined with the signs of pressure mentioned above, varying from mere flattening to complete destruction of the pyramids. The microscope shows that this condition is a mere exaggeration of that found as the result of simple pressure. The change is chiefly and primarily interstitial, but the small-cell growth is so abundant as in many parts to press upon and even destroy the tubules, areas being found in which nothing but crowds of small round cells can be seen. These, when large, form the small yellowish spots visible to the naked eye. It requires only an increased intensity of the inflammation and a softening of these spots to convert them into minute abscesses. As in the form of interstitial nephritis first mentioned, the cell-infiltration is most marked round the Malpighian bodies. The change is rarely uniform throughout the kidney. It varies in degree usually in every field of the microscope, and parts may be found apparently almost healthy. The epithelium throughout the kidney is usually swollen and granular, and readily washes out in preparing the specimen, but it does not choke the tubules as in acute catarrhal nephritis. In very acute cases, small round cells, similar to those outside the tubules, are seen in the lumen of the tube surrounded by epithelium. These have probably found their way in from the outside, and, if washed on by the secretion from above, would appear as pus-cells in the urine. The vessels are often seen to be gorged with blood, and occasionally minute hæmorrhages are present. It is not always easy to distinguish this form of disease by the unaided eye, as, from the pallor caused by the pressure on the vessels from the small-cell infiltration, it closely resembles the fatty kidney or some cases of catarrhal nephritis. The microscope alone can decide the question with certainty. Even in such a kidney the secretion of urine may be moderately abundant. In a case at University College Hospital, the patient excreted over 300 grains of urea on the last day of his life.

3. **Acute Interstitial Nephritis with Scattered Abscesses.**—(Suppuration of the kidney—suppurative nephritis: when accompanied by pyelitis—pyelo-nephritis (Rayer).) This is usually found in conjunction with that form of acute pyelitis in which the pelvis of the kidney is filled with putrid urine, pus, and mucus, but is by no means constantly so. In one case which was observed at University College Hospital, both kidneys were equally riddled with abscesses, but in one the pelvis was acutely inflamed and filled with foul urine, while in the other it was free from disease, and the urine it contained was acid, and without unpleasant smell. The kidney is generally swollen and en-

larged. The fat surrounding it is usually abnormally adherent to the capsule. The capsule is thick and opaque, and marked by ramiform vessels, showing clearly on the surface. It separates easily, but in so doing tears the kidney-substance. The surface of the kidney presents a more or less mottled appearance. The chief tint is the same as in the diffuse form just described, and is, in fact, due to the existence of the same condition; but scattered here and there, usually in groups, are bright yellow spots, surrounded by a dark red areola, and varying in size from a pin's head to a split pea (Fig. 847). On cutting into these yellow spots, each is found to contain a drop of pus. These minute abscesses are usually grouped in areas corresponding to that part of the cortex which belongs to a single pyramid. If now a section be made of the kidney, the points of suppuration will not be found to be limited to the surface. Often they are continued down towards a pyramid, and are connected with a yellow streak running parallel to the straight tubules as far as the papilla, or, if that have been partly destroyed by pressure, as far as the point at which the tubules open into the pelvis. This condition is not invariable, as sometimes the abscesses are perfectly isolated, and show no connection whatever with the pyramidal portion of the kidney. Occasionally one or more of the abscesses may burst beneath the capsule, separating it from the kidney, and, giving rise to further suppuration, may include the whole organ in a large collection of pus. This form of kidney, which is perhaps that most frequently met with in the *post-mortem* room, is often conjoined with the signs of pressure, absorption of the pyramids, and dilatation of the pelvis. The microscope shows that in this form the appearances are essentially the same as in the last; the chief change being the accumulation of crowds of small round cells in the intertubular substance, the degree of cell-infiltration varying in almost every field of the microscope. At the point at which an abscess is forming, or at the margin of one already formed, the crowds of small round cells are seen to press upon the tubules, separating them widely, and squeezing their walls together (Fig. 845). Then the wall becomes indistinct; then only a few epithelium-cells can be recognized in the crowd of leucocytes; lastly, nothing but leucocytes can be seen, and a little nearer the centre the intercellular substance becomes fluid, the cells float free, and pus is thus formed. The red areola is not found to be due to extravasation, although hæmorrhages may exist scattered through such a kidney. The yellow streaks

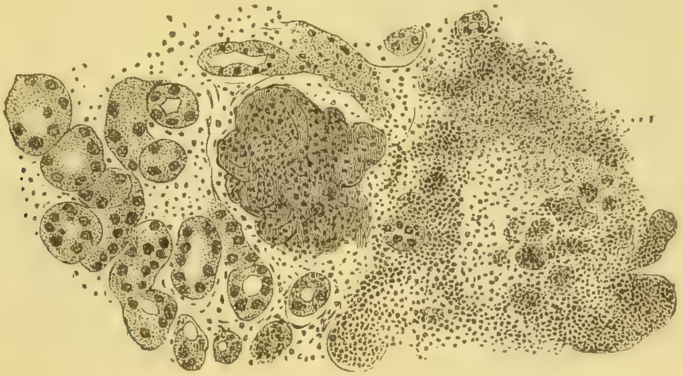


Fig. 845.—Acute Interstitial Nephritis: Scattered Abscesses. Margin of abscess to the right. Malpighian body in the middle. Comparatively healthy tubules with inter-tubular cell-infiltration, to the left.

in the pyramids are found to be due to a similar condition of intertubular cell-infiltration. Sometimes clots may be seen in the vessels of the pyramids. These are probably secondary to the inflammation of the parts surrounding the vessels. As in the former variety, small round cells may be found in the tubules as well as outside them. The epithelium is usually much swollen, and sometimes desquamating and choking the tubules (Fig. 846), but this is only in those areas in which the interstitial inflammation is most advanced. In others it may appear almost healthy. In the pyramidal portion of the kidney many of the large tubes are found to have lost their epithelium by desquamation. This form of kidney merges into the diffuse variety, the solid yellowish spots before mentioned representing points which, had the patient lived longer, might have softened into abscesses. Klebs, many years ago, described the presence of microscopic organisms in the suppurating kidney, but the means of observation were at that time so imperfect that considerable doubt existed as to the correctness of the statement, more especially as he described a micrococcus subsequently developing a branching mycelium—a form of growth, the existence of which was to say the least improbable. Later observations by Koch, with improved methods of staining, have clearly demonstrated the fact that, in every case of disseminated suppuration of the kidney, colonies of micrococci are found scattered throughout the gland, distending and obstructing the urinary tubules. These micrococci are similar to those found in putrid urine, and are believed to be the ferment to which the change is due. The abscesses of the kidney thus arising in acute suppurative nephritis must not be confounded with those seen in pyæmia. These are usually larger, are more distinctly wedge-shaped, and sometimes surrounded by a zone of hæmorrhage. They are always in the cortex, and the pyramids show no signs of disease. Pyelitis is absent, but, as before stated, it may be wanting, or feebly marked in cases of genuine interstitial nephritis, secondary to affections of the bladder. Koch has, moreover, pointed out an important microscopic distinction. Micrococci are found in the pyæmic kidney as well as in pyelonephritic kidney; but in the former they are in the vessels, especially in the Malpighian loops, while in the latter they are in the tubules. Microscopic

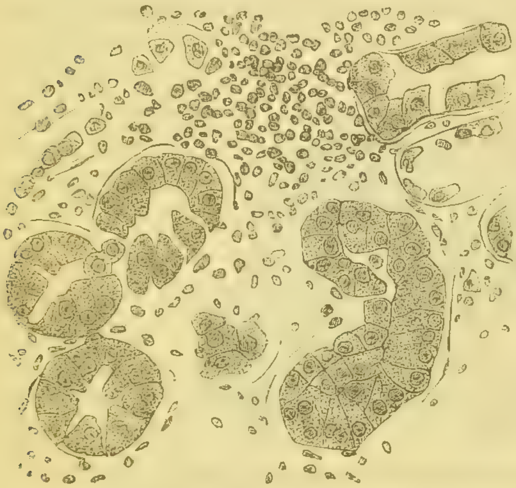


Fig. 846.—Acute Interstitial Nephritis: Condition of Epithelium.

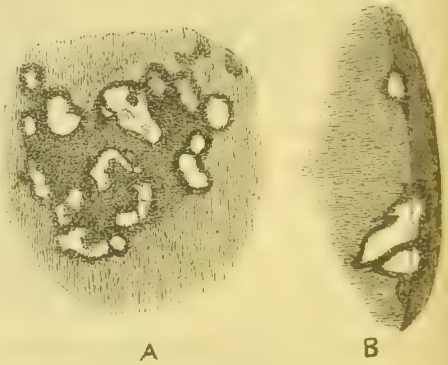


Fig. 847.—A. Group of Abscesses on Surface of Kidney. B. Vertical Section of the same.

examination of a pyæmic kidney further shows an absence of the general diffused inflammation characteristic of the ordinary septic kidney.

4. **Effects of Former Attacks from which the Patient has Recovered.**—It is possible that the kidney may undergo extensive intertubular change, and yet, if the cause be removed, the inflammatory growth may be completely absorbed, and the organ regain its normal condition. More commonly, however, the new growth undergoes a development into fibrous tissue, a change corresponding exactly to that which occurs in the cicatrization of a granulating sore, and accompanied by a similar process of contraction. Thus we get an increase in the intertubular connective tissue, and at the same time a contraction and induration of the whole organ, so much so that it is sometimes reduced to less than a quarter of its normal bulk. If the pyramidal portion have undergone absorption, this is never repaired, but, as its function seems merely that of a duct, its loss is of no great moment. In a kidney of this kind we find the fat adherent to the capsule, and the capsule to the gland-tissue. It strips off with difficulty, and is thick and opaque. The surface of the kidney is irregular, granular, or perhaps even puckered by cicatrices. Scattered over the surface in most cases are numerous small cysts. These are supposed to be due to the strangulation of the tubules by the fibrous growth. The colour is usually dark and somewhat red, with numerous small dilated veins showing on the surface. On section, the cortex will be found to be greatly thinned, being sometimes not thicker than a shilling. The pyramids, unless absorbed from previous pressure, are but little altered. The whole organ is of a leathery toughness which is quite peculiar. The pelvis may be pigmented from previous inflammation. The microscope shows a great increase of the intertubular tissue which is of a dense fibroid character. The tubules vary in size; some are strangulated and compressed, others are dilated above the strangulation. Many of the Malpighian corpuscles are obliterated, leaving merely capsules containing the remains of the obliterated vessels. The capsules of all the Malpighian bodies are greatly thickened. The epithelium may be flattened by pressure, or normal. The small arteries usually show some hypertrophy of their muscular coats. Such a kidney as this may undergo a second attack of acute inflammation, and we then find a combination of the form of the contracted kidney with the colour and softness, and possibly the scattered abscesses, of the acute variety. It will be seen from the above description that this form of kidney differs in no way to the naked eye from the ordinary granular contracted, or gouty kidney. We do not, however, find the general changes associated with that disease. In a case which lately occurred at University College Hospital, in which this condition was well marked as the result of stricture of the urethra, there was no hypertrophy of the heart, and no change could be recognized in the walls of the small vessels in other parts.

Causes of Interstitial Inflammation.—The following may be stated as the causes which in varying degree take part in the production of interstitial inflammation of the kidney: 1. Tension; 2. Reflex irritation of the kidney; 3. The presence of septic matter in the pelvis and the invasion of the kidney by septic organisms. Each of these acting singly may induce serious disease, or perhaps even cause death; but we seldom see such cases. More often two at least are in action.

1. **Tension.**—It has been shown before how this is induced by any obstruction to the free entrance of urine into the bladder. Every practical Surgeon

is acquainted with the fact that tension is one of the most powerful irritants to which the living tissues can be exposed. In the liver, Wickham Legg and others have shown that ligature of the bile-duct causes interstitial hepatitis. In the kidney, no recorded case is to be found of suppuration occurring as the result of simple tension; but in all cases in which evidence of tension exists, that is to say, dilated ureter or pelvis of the kidney, or some source of sudden obstruction as a more or less impacted calculus, subacute interstitial inflammation will be found. It seems almost as if the new cell-growth were a conservative change intended to strengthen the tubules to resist the increased pressure. However this may be, a kidney in this condition is in a state in which a little further irritation from any cause may hurry it on to fatal and acute inflammation.

2. **Reflex Irritation of the Kidney.**—Mechanical injuries to the neck of the bladder or posterior part of the urethra, and probably diseases of these parts in which constantly recurring irritation is present, re-act upon the kidney through the influence of the nervous system. It is needless here to attempt any explanation of the exact manner in which this takes place, as it would be merely a matter of speculation; but a few facts may be given as proof of the assertion. It is well known that several cases are on record, in which death has occurred from suppression of urine following the simple introduction of a catheter, the *post-mortem* examination showing a condition of intense congestion of the kidney. Again, patients with stone in the bladder occasionally die from acute inflammation of the kidney, often accompanied by suppuration, after the operation of lithotrity. Cases of this kind have occurred in which the cystitis was not increased by the operation, in which the decomposition of urine remained unchanged, and no altered circumstance existed, except the mechanical injury of the passage of the instrument, to account for the sudden supervention of acute nephritis. In these cases signs of chronic disease, which has been rendered acute by the additional irritation, are always present. Lastly, a few cases have been observed at University College Hospital after operations for stricture, with the view of ascertaining if any change could be found in the urine as the direct result of the operation. In three cases of Holt's dilatation, the urine was found to be free from blood, or to contain no more than could be accounted for by the operation, during the first hour or hour and a half after the operation, and then to become gradually more and more bloody for another hour or hour and a half, and after that to become gradually free from blood. In one case there was almost total suppression for the first hour and a half, followed by very bloody urine. In one case of internal urethrotomy, during the first hour the urine flowed away in great quantities, and was almost free from blood. For the next six hours it was passed in moderate quantity, and was very darkly tinged with blood. In all four cases, there was reason to believe that the blood came from the kidney. It occurred after the hæmorrhage from the wound would have ceased: it was uniformly mixed with the urine, and free from clots. These cases are of course insufficient in number for any conclusions to be drawn from them; but, as far as they go, they tend to show that, in all cases of operation on the urethra, there is a miniature representation of that intense congestion of the kidney which is found in cases of death from suppression of urine after simple catheterism. Possibly in some cases the dilatation of the vessels is preceded by a contraction of longer or shorter duration, giving rise to the suppression

noted above. In a healthy kidney such an attack of acute hyperæmia soon passes off and does no harm; but, supposing the kidney to be already diseased, the subacute condition may readily become acute and terminate fatally. Repeated attacks of such hyperæmia, which probably result from the irritation of a stone, or passing urine through a bad stricture, would in all probability be alone sufficient to lead to a chronic interstitial change in the kidney. It is a matter of observation, that fatal affections of the kidney scarcely ever result from operations performed on the penile portion of the urethra.

3. **The presence of Septic Matter in the Pelvis of the Kidney.**—This plays the most important part in producing the final acute condition which so often kills the patient. In the first place, the mere presence of such an irritating substance as ammoniacal urine in the pelvis of a kidney already diseased, would certainly intensify the existing inflammation. It seems probable, however, that in many cases the septic matter thus pent up at some degree of pressure (for the thick mixture of mucus, pus, and urine cannot pass the valves of the ureter, already somewhat obstructed by the swollen mucous membrane and perhaps by a hypertrophied or distended bladder, so readily as healthy urine) becomes absorbed by the lymphatics of the kidney, and thus gives rise to a diffuse intertubular inflammation rapidly running on to suppuration. This would account for the pale streaks seen running in many cases parallel to the straight tubules in the pyramids, and expanding in the cortex. The presence of the micrococci in the tubules may also be taken as evidence that the decomposition of the urine may extend far into the kidney-substance from the pelvis. Probably this condition alone is sufficient to account for many cases of acute suppurative nephritis, but it must be remembered that suppuration of the kidney does occur, occasionally, in cases in which the urine in the pelvis is free from decomposition. George Johnson suggests that the scattered abscesses may occasionally be due to rupture of the tubules and local extravasations of urine, and Goodhart has suggested the possible connection between erysipelas and suppuration of the kidney.

The most important observations on this point are, however, those lately published by J. Lindsay Steven. He confirmed the statement of Ludwig that the superficial lymphatics of the kidney are continuous with those of the ureter, and these again with the lymphatics of the bladder. By forcibly injecting the ureter the coloured fluid can be made to pass into the lymphatic vessels on the surface of the kidney, and to a certain extent into the intertubular tissue of the cortex. It is easy to understand, therefore, how micro-organisms and their products can find their way from a diseased pelvis or ureter to the cortical surface of the kidney without passing up the urinary tubules, and also that in ulceration of the mucous membrane from septic cystitis a similar extension may take place from the bladder to the cortex of the kidney without the mucous membrane being seriously implicated. This explains those cases in which multiple abscesses are found in the cortex of the kidney without foul urine being present in the ureter and pelvis. Steven confirmed his views by demonstrating the micrococci in a case of septic cystitis with suppurating kidney, in the superficial lymphatics of the bladder, ureter, and in the capsule and cortex of the kidney.

Symptoms of Kidney-Disease in Surgical Affections of the Genito-Urinary Organs.—*Simple dilatation of the kidney*, although a condition seriously endangering the success of any operation on the urinary organs, gives rise to remarkably few symptoms; and it is surprising to what an extent the structure of the kidney may be damaged by chronic interstitial nephritis arising from this cause without interfering in any noticeable degree with the patient's health. It gives rise to no œdema, no marked anæmia, and no alteration in the function of the skin. The most characteristic feature is probably an increase in the quantity of urine, with a diminution in the specific gravity. In a case lately in University College Hospital, the patient passed five pints of urine daily with a specific gravity of 1003 or 1004. In all cases in which it is desirable to ascertain the condition of the kidneys, the urine should be collected for the whole day, and the specific gravity taken. If the quantity be large and the specific gravity low, chronic interstitial nephritis may be suspected. The quantity of albumen is always small, and it may be absent altogether. At most, only a few hyaline casts can be found, and often no renal epithelium. The excretion of urea is usually in sufficient amount, as the quantity of urine makes up for the low specific gravity. If the primary disease give rise to much pus and mucus, or to a little blood, the difficulties of diagnosis are greatly increased, and reliance must then be placed solely on the quantity and specific gravity, and even these may prove deceptive. It is rarely possible to gain much information by feeling the kidney. There is no tenderness, and it is seldom sufficiently enlarged for the Surgeon to form any conclusion as to its condition.

Subacute interstitial nephritis gives rise to more evident symptoms. The patient is weak and languid, and slowly but steadily emaciates. He loses his appetite and has occasional attacks of nausea, though rarely actual vomiting. His tongue is furred and has a tendency to become dry, and occasionally there is thirst. There is no tenderness over the kidney. There may be occasionally a slight feeling of chilliness, seldom actual rigors. The temperature will be found to be slightly elevated, especially at night; and for this reason, in any doubtful case, it is essential to obtain the evening temperature, as in the morning it may fall to normal. It seldom rises above 101° F. The urine is abundant and usually of low specific gravity, but by no means always so. It is seldom possible to find casts or to judge of the amount of albumen, as this form of disease usually accompanies bladder-affections, which fill the urine with pus or mucus, as chronic cystitis, stone, and stricture. At most, only a few renal epithelium cells and possibly a hyaline cast or two could be found. This condition may last for weeks or even months, the patient gradually becoming weaker and weaker, until he is carried off by some intercurrent disease, or dies of pure exhaustion. More commonly however, an acute attack supervenes on the subacute, either spontaneously or as the result of some surgical interference, and, rapidly ending in suppuration of the kidney, terminates fatally. On the other hand, the symptoms often gradually subside, the temperature becomes normal, and the patient gains strength. The improvement usually coincides with some diminution of the local irritation at the primary seat of disease, such as results from rest in bed in a case of stone, or from the cleansing of a foul bladder. As the symptoms are somewhat indefinite, it is often difficult to say how much is due to renal mischief and how much to the primary affection; but wherever we find a dry tongue, a persistent nocturnal elevation of temperature, loss of appetite, general weakness and emaciation, we ought to make every attempt to get rid of these symptoms before undertaking any serious surgical procedure, such as the treatment of stricture, lithotomy, or lithotrity, the irritation of which might start the smouldering inflammation into activity.

Acute interstitial and suppurative nephritis gives rise to much more manifest symptoms, often supervening on those just described. The attack, which is often induced by some surgical procedure although it may commence spontaneously, begins with a severe rigor, followed by profuse sweating. The temperature may rise to 105° F. or 106° F. After the rigor it falls, but remains somewhat above normal. The rigors and sweating may be repeated more than once. The tongue becomes rapidly dry, red, and fissured, looking like a piece of broiled ham, and sordes accumulate on the teeth. There are complete loss of appetite, and rapid emaciation ; nausea is almost a constant symptom, and actual vomiting is common. Diarrhœa may occur. The patient soon sinks into a heavy drowsy state, often with contracted pupils, so that the condition may closely resemble that of opium poisoning. He can be roused and answers rationally if spoken to, and in most cases complains of little pain or discomfort. The temperature now usually falls, sometimes below normal, and the skin feels cold and clammy. In this form, there is usually some tenderness on pressing firmly in the region of the kidneys. As the case progresses, muttering delirium sets in, followed by more complete insensibility, but it rarely reaches a condition of absolute coma. Convulsions are extremely rare. There is no œdema at any time. The urine varies much. It usually becomes more or less bloody, and in rare cases is suppressed ; much more frequently a considerable quantity is passed up to the time of death. It is usually in such a state from decomposition and the presence of pus, blood, and mucus, as to render accurate chemical and microscopical investigation impossible. Pus-cells are constantly present, but whether they come from the kidney or the bladder in any particular case cannot be ascertained, unless they are found, as in rare cases they are, in the form of pus-casts. In some anomalous cases, diarrhœa forms a very prominent symptom. In one case that occurred in University College Hospital, the stools exactly resembled those of typhoid fever, and the *post-mortem* examination, in addition to suppuration of the kidney, showed ulceration of the lower part of the small intestine.

The duration of an acute attack as above described, when terminating fatally, varies from a few days to a couple of weeks. In favourable cases, even after very marked symptoms, such as the rigors, dry tongue, vomiting, and diarrhœa, the patient may slowly recover. The immediate cause of death seems to be poisoning by absorption of the septic matter from the kidney rather than uræmia. Certainly the mode of death differs greatly from that of acute Bright's disease, the profound coma and convulsions being very rarely present.

The **Diagnosis** has to be made from pyæmia, peritonitis, typhoid fever, and ague. From pyæmia the diagnosis is somewhat difficult, the most important points being the vomiting, the absence of secondary abscesses, the drowsy state into which the patient soon falls, and the fact that the temperature often remains below normal for days before death. The vomiting and extreme illness may resemble the low, diffuse, painless form of peritonitis sometimes seen in affections of the bladder, but the vomiting has not the pumping character of that in peritonitis, and the elevation of temperature for the first few days is unlike that form of peritonitis in which the temperature is persistently low. Suppurating kidney can resemble typhoid fever only in rare cases, and the absence of spots, and the temperature will usually serve to distinguish them. In the case above mentioned, the temperature was below normal for three weeks before death. From ague, the disease is diagnosed by the absence of the complete intermission after the sweating stage; but it must be always remembered that patients who have suffered from ague are singularly liable to attacks of fever after any operation on the urinary organs.

Urethral Fever or Uræmic Fever.—This term has been somewhat loosely used to signify a rigor followed by sweating, and more or less prolonged elevation of temperature, consequent on some operation on the urinary organs, or possibly arising spontaneously. It will be seen at once that this definition includes acute interstitial nephritis, as above described, and also pyæmia. When a patient has been said to have died of "urethral fever," one of these two conditions has been invariably found, although no Surgeon would intentionally include pyæmia under urethral fever. It is probable that the real nature of the affection is, at least in the great majority of cases, a disturbance of the circulation in the kidney, or some interference with its function, due to reflex irritation from the passage of the instrument, as before described in speaking of the sources of irritation to the kidney. That it is not due to absorption of urine from a wound in the urinary passages, is evident from the fact that rigors are rare after lithotomy, and are not common in extravasation of urine, and that wounds of the urethra anterior to the scrotum scarcely ever give rise to them. This view of the renal origin of "urethral fever" is supported by Malherbe, in his treatise on Uræmic Fever, as he would call it. It is difficult to obtain direct proof, but further knowledge might be gained by carefully examining hour by hour the quantity and quality of the urine secreted after any urethral or vesical operation, and at the same time accurately observing the changes in temperature, even when the rigor does not occur. Malherbe states that the temperature rises in almost every case; and in one of the four cases of stricture mentioned before, the temperature rose to 100·3° F. three hours after the operation, when the urine became bloody. It fell to 99·2° F. when the blood disappeared; but three hours afterwards a little more blood showed itself, and the temperature rose to 100·3° F.

Sir Andrew Clark has suggested the quaint name of **"catheter-fever,"** for those cases in which, shortly after the commencement of the habitual use of a catheter, obscure febrile symptoms set in gradually, terminating frequently in death. The symptoms most commonly develop about a week after habitual catheterism has been commenced, and almost invariably in those cases in which it is rendered necessary by enlargement of the prostate or atony of the bladder with partial retention of urine. With the ordinary symptoms of febrile disturbance there is a diminution of the specific gravity of the urine and in the amount of solids excreted by the kidney. There are at the same time but moderate symptoms of cystitis. The symptoms may gradually pass off, or the patient may die exhausted at the end of three or four weeks. At the *post-mortem* examination it is said that the kidneys are found perfectly healthy, and no definite organic change is present to account for death. Sir Andrew Clark is inclined to attribute the fever to repeated disturbance of the nervous system by the passage of the instrument. The attention drawn to this subject by Sir Andrew Clark cannot fail to be productive of further investigation and increased knowledge concerning it, but it remains to be seen how many cases will be left to be included under the name of "catheter-fever" after the elimination of chronic septicæmia and pyæmia, and all cases of chronic or sub-acute interstitial inflammation aggravated by the reflex irritation of the passage of instruments.

Prognosis.—The prognosis in acute affections of the kidney, secondary to bladder disease, is always grave; but even the most unpromising cases may recover. Vomiting, delirium, partial insensibility, and a very dry tongue, are all bad signs. A marked diminution of the quantity, and much blood in the urine, are unfavourable symptoms.

Treatment.—Prevention is of course first to be aimed at. No patient should therefore be submitted to an operation on the urinary organs except in cases of necessity, without a careful examination of the whole day's urine as to specific gravity, the presence and quantity of albumen, and the microscopic appearances. If possible, the temperature should be observed night and morning for two or three days. If any suspicion arise as to the condition of the kidneys, that operation should be selected, when practicable, which gives rise to least irritation. Soft instruments should be employed instead of metal, and a sufficient interval allowed between their use. Above all, any treatment calculated to cause cystitis, or to give rise to decomposition of the urine, should be avoided. As there can be no doubt that the causes of decomposition are often introduced into the bladder by catheters or other instruments, these should be kept scrupulously clean and be washed before and after use in carbolic lotion (1 in 40); they should be greased with carbolic acid and oil (1 to 10). If decomposition already exist in the urine, it should if possible be arrested by washing out the bladder with some antiseptic, for which purpose quinine and diluted sulphuric acid, in the proportion of gr. ij. and m. ij. to an ounce of water, will be found very efficacious; or, better still, 10 grains of iodoform to 4 ounces of water, and ℥ss. of mucilage. If the cause of the renal mischief be stricture of the urethra or stone, some operation must of course be undertaken; but if the temperature be elevated, or there be other signs of renal disease, it should be delayed until an attempt has been made by rest and other remedies to bring the kidneys into a healthy state. If after a few days no improvement be seen, and it seem probable that the disease is kept up by the presence of the stone or stricture, further delay is useless; and, choosing the least severe and irritating procedure, the Surgeon must operate at once.

The treatment of well-marked interstitial nephritis is extremely unsatisfactory. If there be any tenderness in the loins, dry cupping may be of service. The bowels should be well acted on by purgatives, and the skin by hot-air baths, to relieve the kidneys as much as possible. Heroic operations undertaken during acute nephritis in the hope of removing the cause, are almost always, if not invariably, fatal. Quinine and opium have been recommended for the prevention of the rigors that frequently follow catheterism or other operations on the urinary organs. Opium is probably of service, but must be given with great caution if any symptoms of uræmic poisoning exist; but quinine has not, according to most who have tried it, proved of any use. A pure milk-diet will usually be found the best in all cases if the patient can take it; stimulation must be regulated on general principles.

Pyæmia and Septicæmia in Diseases of the Urinary Organs.—These conditions are not uncommonly the cause of death after operations on the urinary passages. Their general symptoms and pathology have been already fully described ; but a few words on the peculiarities they manifest when secondary to affections of the urinary organs may not be out of place here.

Pyæmia may assume the ordinary rapid course of embolic pyæmia, with secondary abscesses in the viscera ; but this is not of very frequent occurrence. Should it occur, softening thrombi will usually be found in the prostatic plexus or in the vesical branches of the internal iliac vein. More commonly visceral abscesses are wanting, the secondary seats of suppuration being most frequently the joints and subcutaneous tissue. In such cases the prognosis, though bad, is not hopeless, as the disease may assume a chronic form, and the patient may recover after long suffering, possibly, with one or more joints stiffened.

Septicæmia may appear under the forms of septic poisoning and septic infection. Poisoning from the absorption of the chemical products of putrefaction is probably the immediate cause of death in many of those cases in which the bladder, ureters, and pelves of the kidneys are filled with foul decomposing urine and mucus. Its symptoms present nothing peculiar. Septic infection may be assumed to be the cause of death in those cases in which there is febrile disturbance of varying severity, preceded or not by a rigor, and ending in death from exhaustion in a period of from a few days to a fortnight or three weeks, and in which at the *post-mortem* examination a definite source of infection can be found, without the presence of such an accumulation of putrid matter in the urinary tract as to render mere septic poisoning probable, and without evident fatal disease of the kidney. Such cases are not uncommonly met with, especially after operations on the urethra, and less frequently after those affecting the bladder. In one case in University College Hospital the source of infection was a slight injury from the point of a catheter to a prominent ridge of a fasciculated bladder. In these cases the wound is found to be covered with an adherent grey layer, closely resembling the false membrane of diphtheria. A section carried through this, and the parts beneath, shows that the membranous layer is composed of a coagulated fibrinous exudation, everywhere crowded with micrococci. The submucous tissue and the parts beyond, show the ordinary appearances of inflammation, and in many cases the micrococci can be recognized invading the affected tissues. In some cases further investigation shows the nearest lymphatic glands to be swollen, and micrococci may be found forming colonies in their substance. Under these circumstances there is strong reason to believe that the diseased spot has been the source of the mischief, and that some infective material has found admission from it, and by infecting the whole system has been the cause of death. The relation of these cases to the chronic form of pyæmia is very close ; possibly, the two conditions are identical, the presence or absence of secondary abscess being merely an accidental variation. The chief peculiarity of the condition is that, although there seems good evidence of a general infective process, it tends to run a somewhat chronic course, sometimes lasting for weeks before terminating fatally, and, probably, in many cases ending in recovery.

CHAPTER LXVII.

SURGICAL OPERATIONS ON THE KIDNEY.

Until within the last twenty years, although some doubtful cases of removal of renal calculi by operation had been recorded, but few affections of the kidney were considered within the reach of surgical interference. Renal abscesses, when distinctly pointing in the loin were opened, and calculi had been in exceptional cases discharged from the opening then made ; but until Simon of Heidelberg, in 1869, successfully removed the kidney, no definite operations were systematically undertaken on that organ.

At the present time the following distinct operations are performed on the kidney :—1. Exploration by acupuncture. 2. Aspiration. 3. Nephrotomy, or incision of the kidney. 4. Nephro-lithotomy, or removal of a stone from an otherwise healthy kidney. 5. Nephrectomy, or complete removal of the kidney. 6. Nephroraphy, or fixing a movable kidney in the loin.

The various morbid conditions for which these operations are required are fully described in works on medicine ; and it is impossible to give here more than the briefest possible summary of the chief symptoms of each, indicating at the same time the operation required for its relief.

Stone in the Kidney.—Deposits of uric acid and oxalate of lime frequently take place in the kidney. In the great majority of cases the calculous matter passes down into the bladder, either in fine particles, when it is commonly spoken of as *gravel*, or in larger masses, when it is termed a *renal calculus*. The passage of any mass of sufficient size to offer resistance on its way down is accompanied by the symptoms of renal colic. There is intense agonizing pain shooting from the loin downwards to the groin, and usually into the spermatic cord and testicle of the same side. In many cases it radiates into the inner side of the upper part of the thigh of the same side. There is retraction of the testicle, and sometimes much nausea or actual vomiting and faintness. As the stone enters the bladder the patient experiences sudden relief. The stone may be passed by the urethra, often with considerable pain and irritation, or may lodge and form a vesical calculus. In many cases, perhaps, after many have been passed at different times, one lodges permanently in the kidney, and then gives rise to the symptoms of stone in the kidney. A renal calculus may form in one calyx, and be permanently fixed there, or it may be situated in the pelvis and send branching processes into the surrounding calyces. The symptoms of renal calculus are the following. There is pain usually referred to the loin, but occasionally radiating downwards in the line of the ureter or to the testicle. The pain is sickening in character and variable in intensity. It is in most cases distinctly aggravated by movement. In some cases walking gives most uneasiness, apparently from the movement of the muscles upon which the kidney lies. In other cases walking causes but little pain, while jolting of any kind causes intense suffering. In other cases any kind of movement is almost unbearable. There may be acute tenderness on pressure over the affected kidney; but in this stage of the disease no enlargement is to be recognized. Frequency of micturition may or may not be present. In some cases it forms one of the most prominent symptoms, so much so that the case may be mistaken for one of disease of the bladder. The urine almost always contains a trace of blood to be recognized by the microscope, and occasional attacks of profuse hæmaturia are common, most frequently brought on by violent movement. In the early stages pus is absent, or only a few corpuscles can be found. Cubical cells are said to occur similar to those forming the superficial layers of the epithelium lining the pelvis of the kidney, but these are not sufficiently definite to draw any conclusion from them, as similar cells may be derived from other parts of the urinary tract.

Treatment.—During the descent of a renal calculus, which always occupies many hours, and perhaps some days, the patient should have full doses of opium, drink bland diluents freely, be put into a warm hip-bath, and have hot fomentations or mustard poultices applied to the loin ; the bowels should also be thoroughly emptied by enemata. It is well to bear in mind, that a somewhat similar train of symptoms to that induced by the descent of the calculus, may be excited by some forms of irritation or flatulent distension of the cæcum and descending colon, which will require appropriate treatment.

Should the stone fail to descend and give rise to the train of symptoms just described, medical treatment may be of much use. An attempt may be made to dissolve the stone by the administration of doses of potash or lithia sufficient to keep the urine persistently alkaline. At the same time the diet must be strictly attended to on the principles laid down in the Chapter on Urinary Calculi. The patient must use distilled water only for drinking purposes. By this treatment the stone appears in some cases to have been dissolved sufficiently to allow of its passage by the ureter. If the patient's circumstances allow of it, several months' rest in the recumbent position may be tried, as under this treatment the calculus becomes encysted and fixed in one calyx, and may cease to cause trouble. If these means fail, the question arises of performing the operation to which the term "nephrolithotomy" has been applied by Morris, who was the first to undertake it. This operation differs so essentially from that performed in the later stages, that it well merits a distinctive name. It must not be assumed, however, that every case of renal calculus is one suitable for operation. The conditions justifying surgical interference are the following :—1. The disease must have lasted sufficiently long to make it certain that there is no hope of natural cure by spontaneous expulsion. 2. The inconvenience caused must be such that it seriously interferes with the patient's enjoyment of life. 3. Medical treatment must have been fairly tried and have failed. 4. The patient must not be passing gravel habitually, as it is evident that under these conditions a fresh stone would probably form in the injured kidney and lodge there after the operation. 5. The symptoms must be distinctly unilateral. 6. The patient must be otherwise in good health, not too old, and especially not too fat. 7. Lastly, if in spite of treatment the symptoms of pyelitis come on, especially a steadily increasing amount of pus in the urine, the operation may be undertaken in the hope of saving the kidney and of preventing the occurrence of pyonephrosis, provided that other conditions are favourable.

Calculous Pyelitis forms the second stage of stone in the kidney. In it the same symptoms as above described persist, but the pain is more constant, though often less acute. There may be great frequency of micturition. The urine, which remains acid, contains a gradually increasing amount of pus, reaching sometimes to many ounces daily. If the several quantities of urine passed during the day be collected, it may be found that the pus is variable in quantity, and may even disappear for a few hours, or even days, its reappearance being accompanied by some relief of the pains in the loin. Intermittent pus in acid urine may be regarded, as Rayer pointed out, as undoubted evidence of pyelitis affecting one kidney only. Before long, the ureter and pelvis, partly obstructed by the stone, become insufficient to drain the pus away, and distinct and often very great enlargement of the kidney sets in. The swelling assumes the ordinary form of a renal tumour, to be subsequently described. The pelvis becomes dilated, the calyces enlarged, the pyramids destroyed, and at last the kidney may be reduced to a multilocular sac, the walls of which are composed of the thinned cortex surrounded by the thickened capsule and the indurated perinephritic fat. (Fig. 848.) Fluctuation is often distinctly perceptible. This condition is termed **Pyonephrosis.** If the disease be allowed to progress unrestrained by treatment, the dilated pelvis or the thickened cortex may give way, and a perinephritic abscess form. The pus then gradually points towards the surface in the loin, but before doing so it may extend widely, from the iliac fossa to below the ribs. In other cases rupture into the colon may take place.

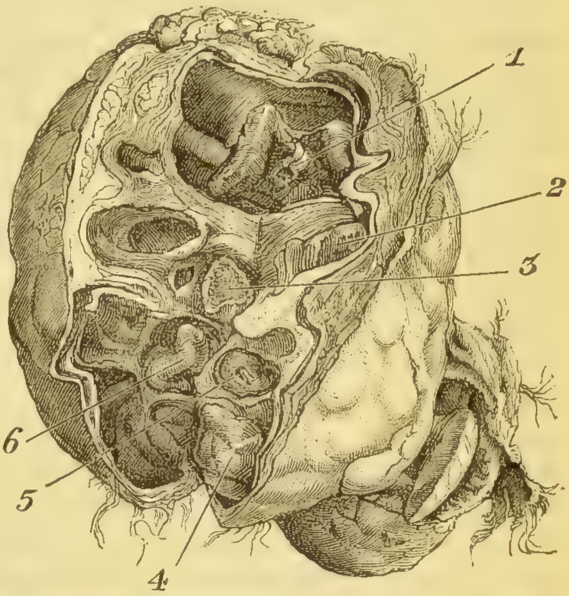


Fig. 848.—Kidney removed for Calculous Pyelitis.

In these cases medical treatment is useless, and early surgical interference gives the only chance of cure. Three operations may be performed; aspiration, nephrotomy, and nephrectomy. Aspiration is seldom of any use in calculous pyonephrosis, except as a means of diagnosis, the needle sometimes grating against the stone as the puncture is made. It may, however, be advantageous to attempt to reduce the bulk of the tumour by aspiration, repeated at short intervals, three or four times before proceeding to nephrotomy. Nephrotomy is the operation specially indicated in these cases. Nephrectomy has been frequently performed for calculous pyonephrosis, but the general opinion at present entertained is that much better results are obtained by removing the calculus by nephrotomy with antiseptic drainage after the operation, followed at some months' interval by nephrectomy if a cure does not result from the simpler operation. The removal of a stone from what must be regarded as the cavity of a large abscess is, as Morris points out, a very different operation from nephro-lithotomy, and should certainly be distinguished by another name, otherwise great confusion must arise in our statistical records.

Tubercular or Scrofulous Kidney.—The pathology and symptoms of this disease are fully described in works on medicine. It will be sufficient to allude here merely to those points that have a bearing on surgery.

Tubercular disease of the kidney is indeed of considerable interest to the Surgeon, not only because he may be called upon to perform nephrotomy or nephrectomy for this cause, but because in a considerable proportion of cases the early symptoms are referred by the patient to the lower urinary tract, and may closely simulate stone and various other vesical affections. Tubercle of the kidney may form merely a part of general tuberculosis, but in these cases the infection occurs late in the disease and gives rise to no symptoms. Primary tuberculosis of the kidney may commence in that organ, and be limited to it for some time, or it may be merely a part of general tubercular disease of the genito-urinary tract. When the disease begins in the kidney, it commences by the formation of a caseating centre in the cortex, or at the base of a pyramid. This softens and gradually extends till, by the destruction of the pyramid corresponding to the affected part, it reaches the pelvis, and the products of the process mixed with pus are discharged with the urine. Several such centres in various stages of softening and disintegration are usually met with in the same kidney. The mucous membrane of the pelvis then becomes affected, and the disease extends to the bladder. In some cases the disease follows the reverse course, commencing in the prostate or bladder, and extending upwards to the kidney. It frequently happens in the later stages that the ureter becomes obliterated. The disease then follows one of two courses: either the chronic suppuration continues and the remains of the kidney become distended into a huge abscess which may finally point in the loin or burst into the gut, or the fluid parts of the pus may be absorbed and the residue form a thick putty-like mass, which may remain unchanged for months or years. The former condition must necessarily occur if any secreting substance remains undestroyed in the kidney. The *post-mortem* appearances of a kidney in the advanced stages are the following:—The whole kidney is greatly enlarged, often to five or six times its natural size. The perinephritic fat is densely indurated by chronic inflammation, and intimately blended with the capsule; the capsule is thickened, but separates with moderate ease from the cortex; the cortex if any remains is thin and tough; the pyramids have disappeared, the pelvis and calyces are dilated, and the whole cavity is filled with a thick creamy or putty-like mass having a sour offensive smell. In less advanced cases only one or two pyramids with the corresponding part of the cortex may be affected. Two important facts with regard to this affection are, first, that in a large proportion of cases both kidneys are implicated, though the disease is always more advanced in one than in the other; and secondly, that if it is at all advanced, the morbid condition extends a greater or less distance down the ureter. The *symptoms* may in the early stage be referred chiefly to the bladder; there may be great irritation and an almost constant desire to pass water, with scalding pain during the act. There is at the same time pain in the loin, usually dull and aching, and not radiating to the testicle or groin. It may be increased by movement, especially of the neighbouring muscles. When both kidneys are seriously affected, constant vomiting may form a marked feature of the case. The urine contains pus, often in considerable amount and intermittent, and the bacillus of tubercle has been recognized in it, and the diagnosis thus established. Blood may occur, but is seldom abundant, and often completely wanting. If both kidneys are affected, the quantity of urine gradually diminishes, and the amount of solids excreted becomes less. As the disease advances, the enlarged kidney becomes clearly perceptible, presenting the ordinary signs of a renal tumour. A chronic abscess gradually forms in the loin in many cases; general tubercular infection takes place, and the patient dies of exhaustion. The diagnosis of the disease is often extremely difficult until the enlarged kidney can be clearly felt. Repeated vomiting, great frequency of micturition, progressive emaciation, the persistent dull character of the pain, the comparative absence of blood in the urine, and the evidence of tubercle elsewhere, as in the prostate or lungs, are the chief points to be attended to; but in spite of every care these cases cannot always be distinguished from stone. The *Treatment* is a matter of great doubt. When abscess forms, early nephrotomy gives great relief, and certainly prolongs life; but should nephrectomy be ever performed for this disease? In the early stages, before the kidney is much enlarged, the diagnosis is so uncertain, even after examination by an exploratory incision, that it could scarcely ever be justifiable to remove the organ. In the later stages, if both kidneys are affected, an operation would evidently be useless, and probably fatal. The disease affects both kidneys in about 35 per cent. of all cases. The difficulties of the operation are also very great, as the kidney is usually firmly adherent to surrounding parts. On the whole, it seems advisable not to interfere with these cases except by nephrotomy.

Pyonephrosis from other causes than stone or tubercle is rare. It is occasionally met with as a sequel to gonorrhœa. In a case of this kind in University College Hospital the patient was completely cured by two aspirations, nearly a pint of pus being removed on each occasion. He died some years after, and the kidney was found to be reduced to a mere shrivelled mass of fibrous tissue.

Hydronephrosis may be congenital, arising from a malformation of the ureter, or may occur as the result of partial or complete obstruction of the ureter by an impacted calculus, or by the pressure of a tumour. The early stages have already been described as the result of increased urinary tension; in exceptional cases only does the dilatation continue to increase till a large tumour is formed. The symptoms are those of a renal tumour, fluctuating distinctly and accompanied by little pain and no hæmaturia. The diagnosis may be confirmed by aspiration and examination of the fluid withdrawn, which will be found to contain urea and uric acid.

Treatment.—Aspiration can evidently be only of temporary service; nephrotomy and drainage would probably be followed by an incurable urinary fistula. Nephrectomy by the abdominal incision has been practised successfully, but probably the best treatment would be antiseptic drainage and subsequent lumbar nephrectomy.

Tumours of the Kidney.—**Cysts** are not uncommon in the kidney, but they seldom reach such a size as to call for surgical interference. The disease known as *cystic kidney* is, however, an exception to this rule. In this affection the whole organ may be converted into little more than a mass of cysts, varying in size from a pea to an orange. The kidney may thus form an enormous tumour, filling a great part of the abdomen and extending down to the pelvis. It is not uncommonly double, but one side is usually more affected than the other. These tumours seem to cause but little trouble beyond that arising from their size, and are often discovered only on the *post-mortem* table. Hydatid cysts are occasionally met with, and may be recognized by the character of the fluid drawn off by the aspirator.

Carcinoma and Sarcoma of the kidney are of moderately frequent occurrence. The sarcomata are frequently met with in infants and young children. They are usually spindle-celled, but striated muscular fibre has been met with in many of the congenital specimens. Carcinoma is usually soft and rapidly growing, and occurs after middle life. These tumours increase quickly, sometimes with little pain, in others with constant aching and uneasiness. The most important symptom is free hæmaturia, and in the absence of this we are never justified in making a diagnosis of renal cancer.

The **Diagnosis of Renal Tumours** is usually not accompanied by any great difficulty. In manipulative examination of a kidney, whether healthy or diseased, the patient must be placed on his back, with the knees drawn up and the shoulders supported. The Surgeon then places one hand in the flank with the tips of the fingers immediately outside the mass of the erector spinæ just below the last rib, and pushes firmly forwards, while with the other hand placed flat upon the abdomen outside the edge of the rectus, he presses backwards. The kidney is thus grasped between the two hands, and in this way a healthy kidney can usually be distinctly felt, and in a diseased organ its size and form can be readily judged of. It is more difficult to estimate the degree of mobility in this way, as the parts to which the kidney adheres in this region are themselves movable. A tubercular or calculous kidney which is really adherent to a mass of indurated fat can often be moved forwards and backwards for some inches. If the tumour be large the hand must next be passed below its border to ascertain by the absence of a pedicle passing into the pelvis that it is not ovarian. When the tumour is of such size that this cannot be done errors are very likely to occur, and numerous cases are on record in which the most accomplished ovariotomists have been deceived, the nature of the case being ascertained only after opening the abdomen. The anterior border of the tumour must next be examined; all renal tumours are rounded in form and lobulation is common. The movement during respiration must not be too much relied upon; renal tumours move less than those of the liver, but are not as a rule fixed. The outline of the tumour must next be ascertained by percussion; it will be found that all renal tumours form an angle with the costal margin, which is less than a right angle. The reverse is the case with splenic tumours and some of those of the liver. The flank will be found to be persistently dull in any position in which the patient may be placed. The most characteristic sign is the presence of the colon crossing the tumour. This may sometimes be recognized by manipulation, and after watching the case for a few days and examining repeatedly so as to hit upon a time when the colon contains flatus, a line of resonance will often be found passing across the dull mass of the tumour. A retroperitoneal sarcoma close to the kidney may not only closely resemble a renal tumour, but may be indistinguishable from it. In these cases the presence of a rapidly-growing soft tumour in the renal region without hæmaturia would lead to a suspicion that it did not implicate the kidney.

The presence of a renal tumour having been made out, it remains to determine its nature. When fluctuation is distinctly present it is probably either hydronephrosis, pyonephrosis or a cystic kidney. A very soft sarcoma may, however, yield a sense of elasticity or even of fluctuation. The diagnosis is best effected by aspiration, during which the nature of the disease may be still further cleared up by the needle impinging on a calculus.

If it be pyonephrosis, the pus has usually a peculiar sickly smell, especially if it be tubercular. In calculous pyelitis it is sometimes offensive from decomposition which has spread up from the bladder. This is far less common in tubercular pyelitis. All renal abscesses may acquire a fæcal smell when they approach very near to the colon.

The lobulated form and great size of the cystic kidney and the absence of hæmaturia would probably serve to indicate its nature. Profuse hæmaturia following the examination is suggestive of malignant disease. In some cases of large accumulations of calculi, grating has been felt during manipulation. The above taken in connection with the symptoms already described will usually enable the Surgeon to determine the nature of a renal tumour with sufficient accuracy.

The **treatment of Carcinoma or Sarcoma** is necessarily limited to nephrectomy. This has been done both through the loin and by the abdomen. If the tumour exceed a moderate size the latter is the only possible method. In smaller tumours the lumbar operation is practicable and has so far yielded the best results. The operation is not to be lightly undertaken. The disease is not usually a very painful one, and for that reason cases of it are seldom seen till the tumour is of considerable size. The immediate mortality is great and the prospect of permanent cure very small. If the disease be detected sufficiently early the operation might, however, give the patient a chance of prolongation of life if not of cure.

Fistulous Communications between the ureter and the uterus or vagina are occasionally met with as the result of injury during labour or during ovariotomy. In these cases the kidney being healthy may be very safely excised by the lumbar incision.

Floating Kidney.—Three degrees of abnormal mobility of the kidney are met with. In the slightest form the organ can be moved upwards and downwards for about an inch beneath the peritoneum ; this is very common. A further degree of movement in the same direction beneath the peritoneum is met with in rare cases, and still more rarely the peritoneum completely surrounds the gland, forming a meso-nephron. The first is recognized only by careful examination ; the two more extreme degrees may give rise to constant and severe pain of a sickening character, occcasionally accompanied by hæmaturia, which can sometimes be induced by handling. These conditions were formerly treated by the application of a padded elastic belt, and although this is seldom efficient it should always be tried before suggesting other means. If it fails and the patient's life is scarcely endurable from the pain in the displaced kidney, operative interference becomes justifiable. Nephrectomy has been repeatedly performed for this condition, but it is a severe measure in a disease not attended by any danger to life ; lately, however, Hahn of Berlin has suggested a simpler proceeding, which has been successfully carried out in several cases and to which he has given the name of *nephro-raphy*. It consists merely in exposing the kidney by the method to be presently described and sewing the perinephritic areolar tissue to the margin of the wound, leaving it subsequently to heal by granulation. The operation is almost free from danger, and should be certainly preferred, if any such proceeding is necessary, to one so dangerous as nephrectomy.

OPERATIONS ON THE KIDNEY.

Exploration of the Kidney.—If the symptoms of renal calculus are well marked, before proceeding to any more severe measure the kidney may be explored, as suggested by A. E. Barker, by means of the aspirator, a long fine needle being used. This is preferable to making use of an acupuncture needle, as the escape of urine shows that the instrument has reached the pelvis. The hilus of the kidney is situated about two inches from the middle line and opposite the first lumbar spine. If the needle be introduced immediately external to the erector spinæ at this level, and passed almost directly forwards it will probably enter the pelvis. Experience, however, has shown that, owing to the thickness of the soft parts covering the kidney, the exploration carried out by this method must necessarily be very imperfect, and cannot be considered conclusive if yielding negative results. The only thorough method of exploration is to expose the kidney before using the needle.

Aspiration of the Kidney.—This operation is performed in the same way as in other parts. A good-sized needle should be used if pus is expected to be present, as it is often too thick to pass through a fine tube. The spot selected must vary with the case, but care should be taken to avoid any risk of puncturing either the colon or peritoneum. In all enlargements of the kidney these are carried forwards. If, therefore, the normal line of the colon, that is to say a line drawn vertically upwards from midway between the anterior and posterior superior iliac spines, be taken, the needle is certain to pass behind the gut if there be any distinct enlargement of the kidney. If any part of the tumour be particularly prominent this may be punctured, but if it be in front of the line just mentioned a careful search for the colon by palpation and percussion should be made. Aspiration, if carefully performed with a clean instrument, is perfectly free from danger.

Examination of the Kidney through an Open Wound, and Nephrolithotomy.—Three incisions have been recommended for exposing the kidney in the loin : a vertical incision immediately external to the edge of the quadratus lumborum, a long oblique, and a transverse or nearly transverse, incision. Of these the last is preferable, as being accompanied by less hæmorrhage, and more fully exposing the kidney. It is best made slightly obliquely, commencing immediately below the free extremity of the last rib, and passing backwards to the edge of the erector spinæ. It must not be made parallel to the rib, but slightly less obliquely, so that its posterior end is from three-quarters of an inch to an inch below the rib. This is necessary to avoid the risk of wounding the pleura, which often extends below the last rib posteriorly for from half to three-quarters of an inch. This incision may be enlarged forwards if necessary, care being taken to avoid wounding the peritoneum ; but should more room be required for any purpose, it is best obtained by cutting from the first incision downwards towards the crest of the ilium, parallel to the outer border of the quadratus lumborum. The position of the patient and early stages of the operation are the same as those of colotomy, except that the incision is placed higher up, and for the anatomy of the parts cut through the reader is referred to the description of that operation (p. 895). The fat about the kidney being reached, the wound must be held forcibly open by copper spatulæ, while an assistant pushes the kidney towards the wound by pressing on the abdomen. The fat is then torn through with fingers or forceps, keeping to the back part of the wound close to the quadratus. If the fat is much indurated by chronic peri-nephritis, considerable difficulty may be found in exposing the capsule of the kidney, but in a case suitable for nephro-lithotomy, in which the kidney is healthy, no difficulty is found in so doing. The sense of resistance offered by the solid mass of the kidney will serve as a guide to the direction in which it is to be sought. This part of the operation is accompanied by little or no bleeding. The kidney, being exposed fully, should now be methodically punctured with a smooth round needle. A common darning-needle held in a pair of torsion-forceps answers the purpose admirably. A piece of carbolized silk may be passed through the eye and tied round the forceps to prevent the needle from accidentally slipping out. If, after a methodical examination carried out over the whole kidney, nothing is felt, the forefingers may be passed before and behind it, and the kidney pressed between them and the pelvis examined. Even after all this, experience has shown that a stone two-thirds of an inch in diameter may escape detection. If the patient's sufferings have been very great, and more especially if there is an increasing discharge of pus, it may be justifiable to cut through the cortex and explore the pelvis with the finger, as even when no stone was present this proceeding has been known in several cases to give great relief.

If a stone be felt, a scalpel may be passed down to it, guided by the needle. As the scalpel is withdrawn, a profuse gush of blood may follow, which is at first very alarming, but the pressure of a sponge for a few minutes arrests it. A pair of polypus-forceps may then be passed in and the wound enlarged by opening the blades. This is accompanied by scarcely any bleeding. The finger may then be inserted, and the stone perhaps hooked out by it ; but if this cannot be done, a pair of forceps must be applied, guided by the finger. It is better in all cases to cut through the cortex, and not to try to open the pelvis. Wounds of the kidney-substance heal readily, but those of the pelvis are apt to leave a fistula. The stone having been removed and all bleeding arrested by temporary pressure on the kidney with a sponge, the external wound may be closed by sutures, leaving an opening at its middle for a large drainage-tube. The urine will probably flow from the wound for some weeks, but in several of the recorded cases rapid healing has taken place. The most extraordinary is that recorded by Bennett May, in which he removed a stone weighing one ounce, and of extremely irregular form, the wound completely healing in five weeks. The dressing should be strictly antiseptic, and while the urine is escaping it must be changed twice a day. Morris recommends finely-powdered German moss-peat as the best absorbent material to place beneath the patient outside the dressing.

Examination of the Kidney by Abdominal Section has been advocated by Knowsley Thornton, as applicable to the majority of cases of calculus, or other diseases of the kidney on the following grounds. First, that by abdominal exploration we can ascertain certainly whether there is another kidney, and if it is healthy ; secondly, the presence of a calculus, and its exact situation can be more accurately determined by manipulation from the peritoneal cavity than from a lumbar incision; thirdly, if it be determined to remove a stone by lumbar nephrotomy, the operation is facilitated by steadying and manipulating the kidney from within the abdomen; fourthly, if the stone happen to be lodged in the ureter, this condition can be recognized and dealt with from the abdominal incision. Lastly, he maintains that the abdominal incision in no way adds to the danger of the operation. In Thornton's own hands the combined operation has given excellent results in several cases, but most Surgeons prefer reserving it for exceptional cases. In all cases in which there is but little enlargement, both sides of the kidney can be examined from the lumbar wound, and probably a stone is not more likely to be missed when searched for in this way than when the kidney is handled from the abdomen.

Nephrotomy.—This consists merely in making an incision into a kidney distended with pus or urine. The incision must be in the same position as that just described, but need not be so extensive, as no exploration of the surface of the kidney is required. The surface of the enlarged kidney being exposed it must be punctured by a broad-bladed scalpel, and the finger inserted at the puncture before the fluid escapes. In this way the dilated calyces are easily examined, and should a stone be present it may be removed. After the operation a large drainage-tube is inserted, reaching well into the pelvis of the kidney; this must be gradually shortened as the cavity closes. The dressing should be antiseptic throughout. Nephrotomy for calculous pyelitis is often successful; for tubercular pyelitis scarcely ever so, although it gives relief and prolongs life. If a sinus remains, the drain from which is exhausting to the patient, the question of lumbar nephrectomy must be considered. The operation, far from being increased in difficulty, is actually facilitated by the previous drainage.

Nephrectomy.—By nephrectomy is meant the complete extirpation of the kidney, an operation that a few years since would have been considered as unsound in physiological principle as impracticable to surgical art. Before proceeding to the removal of the kidney, it was necessary to ascertain that a person could not only live, but that the health might be maintained after the removal of so important an organ. That this is possible has been proved by the result of injury, by pathological research, and by physiological experiment. There are cases on record in which, in consequence of a deep stab or cut in the loin, one kidney has been wounded and forced out of the wound, whence it has been removed after ligature of its pedicle, the patients making a good recovery. Then, again, it has long been known to pathologists that a person may live with one kidney practically useless, either blocked by calculus, destroyed by suppuration, or converted into a mere sac in hydronephrosis. Simon, of Heidelberg, proved by numerous experiments on dogs that one kidney might be extirpated without danger, and that the animal enjoyed perfect health afterwards.

The ground having thus been cleared, Gustav Simon was encouraged to undertake the operation for the extirpation of one kidney. This he did in 1869, in the case of a woman who, having had the ureter cut across in the operation of ovariotomy, was left with a urinary fistula otherwise incurable. The kidney, which was healthy, was removed by a lumbar incision. The patient made a good recovery. Seven years after the operation she was in perfect health. Since that time the operation has become an established one in surgery, and has frequently been performed.

The conditions under which nephrectomy is undertaken have been already described. It must always be borne in mind that the gravity of the operation is such that it should never be performed except for conditions threatening life. In all cases, before undertaking it, the condition of the other kidney must be ascertained if possible. Various means have been suggested for doing this. Catheterism of the ureter, even in the female, cannot be carried out with sufficient certainty to be of any use. R. Davy has proposed pressure on the ureter leading from the diseased kidney by means of the same lever that he employs in compression of the iliac. It remains to be seen whether this is practicable. At present no means of cutting off the flow of urine from one kidney while examining that from the other can be said to be practically efficient. Exploration by abdominal section is in fact the only method by which the state of the other kidney can be ascertained with absolute certainty, but a sufficiently accurate opinion may in most cases be formed without it. The sound kidney must be examined by manipulation for enlargement or tenderness. The quantity of urine and the amount of urea must be examined for several days. A marked deficiency in the quantity of urine excreted, or in the solids eliminated by the kidneys, is also a grave sign. Severe vomiting should always lead to a grave suspicion of double disease. In spite of these precautions, however, the only working kidney has been removed more than once. In one case in University College Hospital nephrotomy was performed and some pus let out by a free incision. The wound healed and the patient was well for three months. The symptoms then returning nephrectomy was performed and the patient died on the sixth day of complete suppression of urine. The other kidney was found to be completely destroyed by old tubercular disease. This shows that we must not assume that the other kidney is sound because the patient has passed safely through nephrotomy.

The operation may be performed by the *lumbar* or the *abdominal* incision. If the lumbar method be adopted the transverse incision, with the vertical extension carried from it to the crest of the ilium is the best, as giving most room. The early steps of the operation are the same as in nephro-lithotomy. When the capsule is reached this must be opened in cases of calculous or tubercular pyelitis ; in other cases it should be preserved uninjured if possible. The kidney is then carefully enucleated with the fingers of one hand till it remains attached merely by its pedicle. In doing this care must be taken to keep close to the gland lest the peritoneum or colon be torn. The tumour may now be drawn forwards in the wound, and if the ureter can be isolated, this should be done and a double ligature passed round it. It may then be divided between the ligatures, its end being touched as it is cut with a solution of chloride of zinc lest septic matter pass from it into the wound. In cases of pyonephrosis it is usually impossible to separate the ureter from the rest of the pedicle. A strong carbolized silk ligature is now passed through the pedicle, and it is tied in two pieces. If this be done carefully with a blunt aneurism-needle there is no fear of puncturing the renal vein. The pedicle at this stage must not be dragged on too forcibly, first, for fear of tearing it, and secondly, lest on the right side the ligature be applied too close to the vena cava. The pedicle having been securely tied, the kidney is cut off with a pair of scissors, not too close to the ligature. All bleeding having been arrested, the ligatures are cut short and the wound is closed, a large drainage-tube being inserted and the case treated as an ordinary wound in any other part of the body by some form of antiseptic dressing. The chief dangers during the operation are hæmorrhage from the substance of the kidney in the case of a tumour, wound of the peritoneum, and wound of the colon in cases of pyonephrosis. These are avoided by keeping outside the capsule in the former case, and inside in the latter. The shock of the operation is great and often directly fatal.

Abdominal Nephrectomy is performed with all the precautions already laid down as being necessary in abdominal operations (p. 793). The incision now adopted in all cases is that recommended by Langenbuch in the linea semilunaris. It has the great advantage over the median section of more directly exposing the pedicle, and of enabling the intestines to be held more readily on one side during the operation. When the surface of the tumour is exposed, the peritoneum external to the colon must be carefully divided, all bleeding being immediately arrested by forci-pressure forceps. The pedicle is then carefully exposed and the vessels ligatured, either separately or in the same way as in the lumbar operation. The ureter is then divided between two ligatures, care being taken that while so doing none of its contents pass into the abdominal cavity. The divided ends must be immediately disinfected with chloride of zinc (40 gr. to ℥j.). The enucleation of the tumour can then be completed. Barwell has recommended that an aperture for the drainage-tube should be now made in the loin, and in cases in which the raw surface left after the removal of the tumour is very large this would undoubtedly be a wise precaution. The wound is closed in the ordinary way. The operation should be performed with all antiseptic precautions.

In the after-treatment of nephrectomy the patient must be covered up as warmly as possible to promote the action of the skin. Vomiting is almost always a troublesome symptom, and must be relieved by ice. Opium must be used sparingly, as the opposite kidney often becomes congested and somewhat disturbed in its functions for a few days.

The **Results of Nephrectomy** were at first very discouraging, for out of the first 12 cases in which the operation was done but 2 recovered. But increased experience in the operation, a more just appreciation of its difficulties, and, above all, the great advances in abdominal surgery generally, have during the last ten years turned the balance in favour of the operation, so that the recoveries now exceed the deaths.

Gross has collected 233 cases, of which 129 recovered and 104 died, or 44·63 per cent. The lumbar incision was adopted in 111 cases, with 41 deaths or 31·93 per cent. ; while of 120 operated on by the ventral incision, 61 died or 50·83 per cent. The most common cause of death in both operations was shock. Peritonitis caused 21 per cent. of the deaths after the abdominal operation. In five cases disease of the opposite kidney was the cause of death. and 4 of these were after the lumbar operation. The operation was performed for suppurative lesions in 73 cases with a death-rate of 43·9 per cent. Nephrotomy in 93 cases proved fatal in 23·6 per cent. In 12 nephrectomies after nephrotomy there was only one death. Gross estimates that in suppurative lesions preliminary nephrotomy and drainage reduce the death rate of nephrectomy by no less than 41·4 per cent. The operation was performed for tubercular kidney, 20 times with a death-rate of 40 per cent. ; for hydronephrosis in 21 cases with a mortality of 38 per cent. ; for cysts in 15 cases with a death-rate of 46·6 ; for painful floating kidneys in 22 cases with a death-rate of 40·9 per cent.; for malignant growths in 33 cases with a mortality of 57·5 per cent.; for other tumours in 4 cases with 1 death; for calculus in 21 cases with a mortality of 9·5 per cent.; for ureteral fistulæ in 12 cases with a mortality of 21·2 per cent.

Gross concludes from the careful study of nearly 450 cases of different operations on the kidney—1. That lumbar nephrectomy is safer than the abdominal operation; 2. that primary nephrectomy is indicated in sarcoma in adults, in benign neoplasms at any age, in early tubercular disease, in rupture of the ureter and in ureteral fistulæ. 3. That nephrectomy should not be resorted to till after the failure of other measures, in subcutaneous laceration of the kidney, in protrusion of the kidney from a wound, in recent wounds of the kidney or ureter during abdominal operations, in all suppurative lesions; in hydronephrosis and cysts, in calculus in a healthy kidney and in floating kidney. 4. That nephrectomy is absolutely contra-indicated, in sarcoma in children, in carcinoma at any age unless diagnosed very early, and in advanced tubercular disease.

CHAPTER LXVIII.

URINARY CALCULUS AND LITHOTOMY.

URINARY DEPOSITS AND CALCULI.

The urine is liable to deposit various solid matters, which when impalpable are termed **Sediments**; when in fine gritty particles, **Gravel**; and when forming a larger concrete mass, **Calculus or Stone.** These deposits may be the result of constitutional abnormality, and the conditions giving rise to them are then sometimes termed a **Diathesis.** Much importance was formerly ascribed to these so-called diatheses, as it was believed that there was some definite constitutional condition corresponding to each form of urinary deposit; but this view can no longer be maintained.

Uric or Lithic Acid Deposits.—These occur in two forms, as free uric acid and as urates. Free uric acid, in the form of crystals, is never met with in healthy urine. When it forms a deposit it appears as small red grains which may be compared in general appearance to cayenne pepper. Under the microscope it is found to be crystalline. The form of the crystals varies considerably; most commonly they appear as smooth, transparent, rhomboidal plates, mixed with which may be diamond-shaped, prismatic, or needle-shaped crystals. Occasionally they are barrel-shaped (Fig. 849). As a rule they are darkly stained with urinary pigment and present a reddish colour, but the tint varies greatly in different cases. The crystals are readily soluble in dilute solutions of potash or soda.

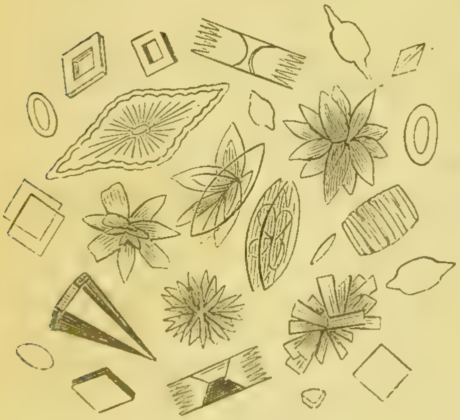


Fig. 849.—Uric Acid.

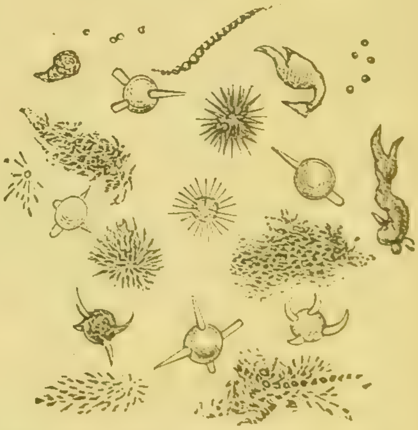


Fig. 850.—Urate of Ammonia and Amorphous Urates.

Urates form the common pale yellow or reddish-yellow deposit which is so frequently observed to form as urine cools after being passed. This deposit, often termed *lateritious*, is amorphous, and has no very definite chemical composition, consisting of uric acid, combined with soda, potash, and ammonia in varying proportions, with traces of lime and magnesia. The depth of colour is proportional to the amount of pigment in the urine.

Urate of ammonia (Fig. 850), in the form of spiked globular masses, is occasionally met with alone or mixed with amorphous urates. The amorphous urates are readily recognized clinically by their completely dissolving when the urine is warmed. Free uric acid and urates are not uncommonly found together.

Uric acid is one of the products formed in the elimination of refuse nitrogenous material from the body. Under normal circumstances by a process of oxidation it becomes converted into urea and carbonic acid, the former being eliminated with the urine and the latter by the lungs. Such uric acid as remains unoxidized is excreted in the form of urates in such quantity as is, under normal conditions, readily soluble in the urine. The presence of an excess of uric acid is therefore due to imperfect oxidation. The deficiency of oxygen may be absolute, as when the patient is confined to close ill-ventilated rooms, and takes insufficient exercise in the open air, or when he suffers from some disease interfering with respiration, as phthisis or emphysema, or when, from the deficiency of red corpuscles, the blood is not in a state to take up the necessary quantity. In all these conditions copious deposits of lithates are habitually met with. In other cases the supply of oxygen is normal in amount, but the refuse products to be oxidised are excessive. This may arise from an excessive supply of nitrogenous food, or in fact, of food of any kind, for there seems reason to believe that the carbo-hydrates, starch, sugar, &c., and alcohol, exert a sort of preference claim on the oxygen, and if supplied in excessive quantities leave an insufficient amount for the perfect oxidation of the refuse nitrogenous substances arising from the natural waste of the body. These deposits are therefore commonly met with in individuals of a robust habit of body and florid appearance who have lived too well. Copious deposits of urates occur also in all febrile conditions which are invariably associated with an increased waste of the tissues of the body. Violent and prolonged muscular exertion may produce the same effect.

Excess of uric acid in the blood, as was clearly demonstrated by Sir A. Garrod, is an essential feature of gout. In this disease deposits of uric acid, either as lithates, or as pure uric acid, are always met with in the urine; and the gouty deposits in joints and other structures are composed of urate of soda.

Uric acid is frequently met with in unhealthy children of the poor and less commonly among the children of the rich, who are allowed more animal food than they can readily digest.

The mere deposit of the normal quantity of lithates on the cooling of the urine, concentrated by excessive sweating, may be regarded as a natural condition.

Uric Acid Calculi.—The calculi containing uric acid are of two kinds; the pure uric acid and the urate of ammonia. Uric acid in the form of minute concretions forms the most common variety of gravel. When a distinct calculus is formed it is usually of regular form, oval, somewhat compressed and flattened, smooth, or slightly nodular on the surface, and of a fawn colour. On section it is seen to be laminated, and to present various shades of light brown or fawn tint. Fissures are occasionally met with in its structure, the origin of which it is difficult to explain, and in rare cases the whole stone has been known to break up spontaneously into small fragments. The urate of ammonia calculus is of very rare occurrence; it is met with chiefly in children, is composed of concentric rings, has a fine earthy appearance, and is clay-coloured. The uric acid calculus may be distinguished from the urate of ammonia by heating a fragment in solution of caustic potash: both dissolve, but the latter evolves ammonia in the process of solution.

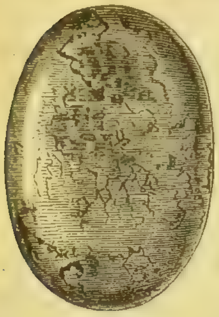


Fig. 851.—Uric Acid Calculus.

The **treatment of uric acid deposits** must be directed to the removal of the prime causes of this condition, viz., mal-assimilation, defective oxygenation, and the ingestion of too large a quantity of nitrogenous food. All these may be remedied by attention to ordinary hygienic measures; the patient must live sparely, should avoid fermented liquors, especially red and effervescent wines, and abstain from sweets, pastry, &c. He should take plenty of out-door exercise, and keep the skin in healthy action by warm dry air or vapour bathing, and the use of horsehair gloves. The bowels also must be carefully regulated by means of saline and other aperients, with occasional alterative doses of blue pill; to which, if the constitution be peculiarly rheumatic or gouty, some colchicum may advantageously be added. Preferable to all medicines, perhaps, are the natural aperient saline waters of Püllna, Friedrichshall, or Carlsbad, taken fasting. The patient may also be directed to drink some of the natural alkaline waters, as those of Vichy, Vals, or Fachingen. The Vichy waters, containing a large quantity of carbonate of soda, with free carbonic acid, are often extremely serviceable. If they cannot be procured, a very good alkaline drink consists of a scruple of bicarbonate of potash and five grains of nitre dissolved in a tumbler of cold or tepid water, to which about five grains of citric acid or a tablespoonful of lemon-juice may be added; this should be taken early in the morning or in the middle of the day. The preparations of lithia are of essential service in removing uric acid gravel or in clearing the urine of urates. They may be given alone, or in combination with the citrate or carbonate of potash.

Deposits of Oxalate of Lime.—Oxalate of lime appears in two forms, as octahedra (Fig. 852), and as dumb-bells. The crystals are colourless or nearly so. The dumb-bells sometimes become agglomerated into small rounded masses, forming the so-called hemp-seed calculi. The origin of oxalate of lime in the urine is a somewhat doubtful point. Oxalic acid is not present normally in the urine, and is supposed to be derived from uric acid by imperfect oxidation. It has been ascribed also to the imperfect oxidation of the carbohydrates taken as food. Certain articles of diet, as sorrel and rhubarb, which contain oxalates in considerable quantities, will cause their presence in the urine. It was formerly supposed to be associated with marked symptoms indicating the so-called oxalic diathesis, the patient being pale, hypochondriacal, dyspeptic, and suffering from acidity of the stomach, disturbed sleep, and loss of sexual power. Sir W. Roberts, however, states that oxaluria accompanies no constant train of symptoms, and asserts that the presence of oxalates furnishes no definite indication for treatment. Urine containing oxalates is usually pale, abundant, and acid, and may cause some sensation of heat and pain in its passage along the urethra. It forms no definite deposit, but is usually associated with a slight excess of mucus. The crystals adhere to the side of the glass in lines corresponding to any irregularity in the glass, or to marks left by the cloth used in wiping it out. There is strong reason to believe that in many cases the oxalic acid is produced during the early stages of decomposition after the urine has been passed.

Oxalate of Lime Calculus.—The oxalate of lime or mulberry calculus is usually of a dark brown or even black colour, rough, tuberculated, and sometimes almost spiculated on the surface (Fig. 853). It is very heavy and hard. It seldom reaches a great size, as the irritation it causes calls attention to it early. Oxalic calculi of small size are not unfrequently passed as gravel.

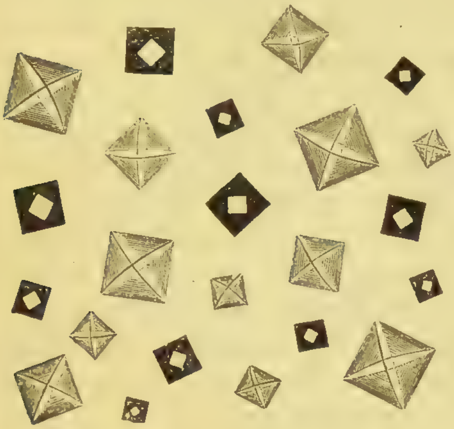


Fig. 852.- Crystals of Oxalate of Lime.

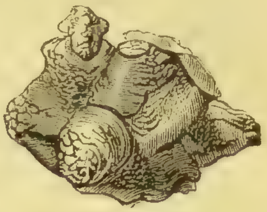


Fig. 853.—Very rough Oxalate of Lime Calculus.

Treatment.—When the patient habitually passes oxalates, and especially if they appear as gravel, he must be put upon a light and nourishing diet, especially fish, as recommended by Bird, cautioning him to avoid sweets and all fermented liquors, with the exception of a moderate quantity of weak spirits and water. Tonics, particularly the mineral acids, iron, zinc, and quinine, may be given, and the residence should, if possible, be changed for a time to a warm climate. Distilled water only must be used for drinking purposes. When calculus is formed, there is, owing to its roughness, usually a good deal of pain in the region of the bladder, requiring the free administration of opiates.

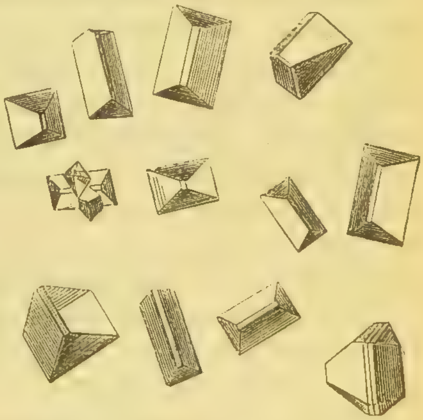


Fig. 854.—Crystals of Ammonio-Magnesian Phosphate.

Phosphatic Deposits.—The sediments and calculi containing phosphates occur in three distinct forms: 1. Triple or Ammonio-Magnesian Phosphate; 2. Phosphate of Lime; and 3. Mixed Phosphates, consisting of a mixture of the preceding varieties.

1. The **Triple or Ammonia-Magnesian** phosphate is met with in all specimens of urine that are decomposing. It has no pathological significance, and is not associated with any special constitutional condition. It forms the chief part of the white crust which is deposited on all instruments tied into

the bladder for any length of time, and on all stones which have given rise to severe cystitis.

2. The **Amorphous Phosphate of Lime** is deposited whenever the urine becomes alkaline, whether from the administration of alkaline drugs, from the presence of alkaline mucus in large quantities secreted from an inflamed bladder, or from the formation of carbonate of ammonia from decomposition. It very rarely forms a concretion alone. Excess of phosphates is met with in some forms of disease of the nervous system, but unless the urine be at the same time alkaline it does not form a deposit. Amorphous phosphates are very frequently passed a few hours after a meal, during the so-called "alkaline tide" in the urine, especially about eleven or twelve o'clock after a heavy late breakfast. This occurs more readily if the actual amount of phosphates be in excess. The causes of this condition are not very clear, but the alkalinity can easily be shown in many cases to be due to the presence of alkaline carbonates, the urine effervescing vigorously on the addition of any acid. It is frequently associated with late hours and over-work. The patient is often much alarmed by the appearance of the phosphates, as they usually come at the end of micturition, forming a white cloud in the stream which he may take for seminal fluid. If the phosphates are very abundant they often hang about in the urethra, and may cause severe smarting or burning pain after micturition. The condition is easily detected by examining the urine. The white heavy deposit looking almost like pus disappears immediately on the addition of a little acid.

3. **Mixed phosphates** are usually met with in all cases of disease of the bladder with ammoniacal urine, as in the cystitis following an injury to the spine, or in advanced cases of prostatic disease.

Phosphatic Calculi.—Pure phosphatic calculi are very rare, if we exclude those soft concretions that form in a foul bladder. They are commonly composed of mixed phosphates in varying proportions. If the proportion is about two parts of the ammonio-magnesian to one part of the phosphate of lime, it fuses readily into a bead before the blow-pipe, and has hence been called the fusible calculus. This calculus is friable, laminated, and has a chalky or earthy look. The ammonio-magnesian calculus is less common. It may be beautifully crystalline in structure. The phosphate of lime calculus is still more rare, as the amorphous phosphates seem to show but little tendency to agglomerate into a concretion. The few that have been met with are laminated and harder than the other phosphatic stones.

The **Treatment of the deposit of phosphates** is in most cases purely local, decomposition of the urine being prevented, and the bladder kept clean by those means that will be described in the chapter on cystitis. The passage of amorphous phosphates may be treated by avoidance of overwork and late hours, and by exercise in the open air, a few days of which treatment will usually cause a complete disappearance of the symptoms. Tonics, especially nitric acid or nitro-hydrochloric acid and tincture of nux vomica, are often of use.

Cystine is one of the rarer forms of morbid product occasionally met with in the bladder. It differs from all other ingredients in containing a large quantity—about 26 per cent.—of sulphur. It is very rarely seen as a sediment in the urine; but when it occurs in this form it presents the microscopic characters seen in Fig. 855, being composed of hexagonal laminæ.

The causes which lead to its formation are uncertain, but the tendency to it is often hereditary. Calculi containing cystine are occasionally met with. Golding Bird states that in Guy's Hospital museum there are eleven; and in the museum of University College we have some good specimens. Cystine in calculus has a peculiar yellowish colour, becoming green after exposure to the air, and a waxy look, quite peculiar to itself. Friction applied to its cut surface causes it to emit a smell like that of garlic.

Xanthine, or **Xanthic Oxide,** was first noticed by Marcet, and has since been observed by Laugier, Langenbeck, and others. It is of extremely rare occurrence, and has been found in only four recorded instances in the form of calculous concretions. These have generally been of small size, with the exception of the one removed by Langenbeck, which weighed 388 grains. For a detailed account of the chemical characters and constituents of this substance, as well as of the other materials of which calculi are formed, I must refer to the works of G. Bird, Beale, and Ralfe.

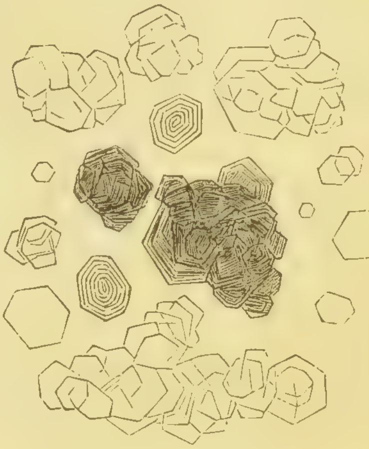


Fig. 855.—Crystals of Cystine.

Carbonate of Lime has occasionally been met with as an amorphous powder in alkaline or very faintly acid urine. Bird states that he detected carbonate of lime as forming a distinct stratum in some phosphatic calculi; and Thudichum has examined prostatic concretions consisting almost entirely of this substance—the urinary origin of which, however, he doubts. Vesical calculi composed of carbonate of lime are certainly very rarely met with.

Chemical Examination of Calculi.—For a complete account of the chemical examination of urinary calculi I must refer the reader to works on medical chemistry by C. H. Ralfe and others. The following rough tests may, however, be employed for the three chief varieties, the other forms being so rare that they may practically be excluded from consideration. Place a small fragment on a piece of platinum foil, and hold it in the flame of a spirit lamp. If it burns completely away, or at most leaves a scarcely appreciable residue, it is probably uric acid or urate of ammonia. If it blackens and then leaves a white residue of the same size as the original fragment, it is either oxalates or phosphates. Then place three very small fragments on three glass slides, and add by means of a glass rod a drop of dilute liquor potassæ to one, of acetic acid to another, and of dilute hydrochloric acid to the third. If it dissolves in the liquor potassæ it is either uric acid or urate of ammonia; if it dissolves in acetic acid and hydrochloric it is phosphates; if it dissolves in hydrochloric acid and not in acetic it is oxalate of lime. If it dissolves in liquor potassæ, put a glass slip cover over it and then run in beneath a drop of acetic or hydrochloric acid; as the acid meets the alkaline fluid a white cloud will appear, examine this under the microscope and it will be found to be composed of diamond-shaped crystals of uric acid. As a confirmatory test for oxalate of lime, the white residue left after heating on the platinum foil may be placed on a glass slide and a drop of acid added, when it will be seen to dissolve with effervescence, oxalic acid having been broken up by the heat, and carbonate of lime remaining.

STONE IN THE BLADDER.

Structure of Calculi.—Calculi, though sometimes composed throughout of the same deposit, are frequently made up of layers or strata, differing in chemical composition from one another, and these usually go by the name of *alternating calculi* (Fig. 856). Most frequently the nucleus consists of uric acid; next in order of frequency comes the oxalate of lime; and then the concretion of a phosphatic character throughout. It is very seldom that the nucleus is absent; but concretions have occasionally been met with in which none could be detected, or in which it was even replaced by a cavity. The nucleus is usually as nearly as possible in the centre of the calculus, and is generally nearly regular in shape; occasionally, however, it is branched or curiously radiated, and then the concretion generally affects a corresponding outline. Calculi containing two or three nuclei have sometimes been found, consisting probably of an equal number of concretions agglommerated together. A foreign body occasionally takes the place of a nucleus.

The body of a calculus having the uric acid nucleus is generally composed of the same substance possibly mixed with some urates; but not unfrequently these are incrusted with deposit of phosphates. In other instances the body may be wholly composed of some of the earthy phosphates, which more rarely alternate with the oxalate of lime or the triple phosphates.

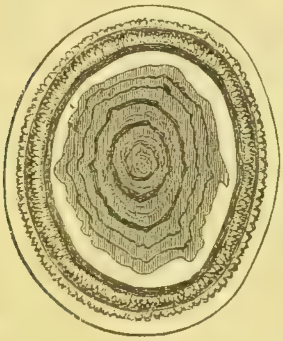


Fig. 856.—Section of an Alternating Calculus.

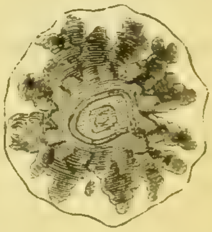


Fig. 857.—Section of Oxalate of Lime Calculus incrusted with Phosphates.

An oxalate of lime nucleus usually has a body of the same constitution; but in some cases it is incrusted with phosphates or urates (Fig. 857). When the interior is phosphatic, the concretion is always of the same constitution.

The alterations in the composition of a calculus are due to varying conditions of the general health, and consequently of the character and constituents of the urine, and of the state of the lining membrane of the bladder. The uric acid and oxalate of lime nuclei and layers are undoubtedly due to constitutional causes. The phosphatic laminæ, whether interposed between the uric acid or incrusting the calculus, are dependent on vesical irritation and decomposition of the urine, consequent on the presence in the bladder of the uric acid or oxalate of lime nucleus which has been previously formed.

Origin.—Calculi may be formed either in the kidneys or in the bladder. Those that contain nuclei of the urates or oxalates are probably renal in their origin; whilst those that have a phosphatic nucleus are usually vesical, renal nuclei of this composition being rarely met with.

All renal calculi, all those vesical calculi that have a renal origin, and some of those even that appear to be primarily formed in the bladder, have a constitutional source; they arise from a morbid state of the urine, which in its turn probably depends upon mal-assimilation, the particular form of which determines the chemical composition of the stone. Those calculi that are formed by deposit from the urine upon and around some foreign body, as a pin or straw accidentally introduced into the bladder, and some soft phosphatic concretions that appear to be the result of an unhealthy state of its mucous membrane, may be looked upon as being local in their origin.

The symptoms arising from a stone in the kidney, and during its passage to the bladder have already been described (p. 971). Though a vesical calculus often owes its origin to the descent of a stone from the kidney, yet frequently there is no evidence of its coming from such a source, but every appearance of its being deposited in the bladder; a nucleus being originally formed in the viscus by the aggregation of some sabulous matters, upon which fresh deposits take place, until a true calculus is formed. In some instances, vesical calculi have been found deposited upon and incrusting foreign bodies, accidentally introduced into the bladder, such as a piece of straw, a pin, bit of bougie, fragment of bone, &c.

Number.—The number of calculi in the bladder varies considerably; most commonly only one is encountered; but in about one-fifth or one-sixth of the cases operated upon, several will be found; from two to six or eight are by no means uncommonly met with. Occasionally, several dozens have been detected; and there are instances on record in which even some hundreds of distinct and separate calculi have been found in one bladder. The most remarkable case of this kind is one in which Physick removed from a Judge in the United States upwards of a thousand calculi, varying in size from a partridge-shot to a bean, and each marked with a black spot. Several calculi may become matted together in one large concretion, as in the annexed representation of a calculus (Fig. 858) that I removed from a child four years old; it was formed of eleven distinct uric acid calculi soldered together in this way; besides which, three others were loose in the bladder. When two or more calculi occur they often are uniform in shape, size, and weight, one being the exact counterpart of the other. This symmetry is remarkable when the calculi are very numerous, dozens of small stones of exactly the same size, shape, and weight, being met with. One large calculus is very rarely, if ever, found associated with numerous small ones.

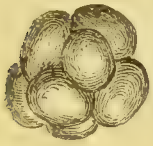


Fig. 858. — Uric Acid Calculi matted together.

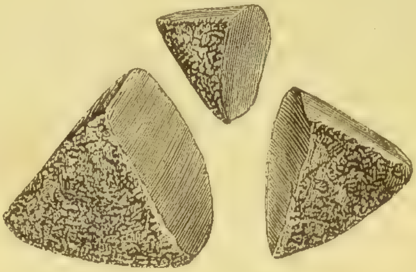


Fig. 859.—Calculi with Facets.

When there are several calculi in the bladder, the attrition of one against the other usually causes the opposing surfaces to become smooth, thus constituting "facets" (Fig. 859). In some cases, however, when the calculi are numerous, there are no signs of attrition. This is probably owing to the bladder being atonic, always containing urine, and thus not compressing and grinding the calculi against one another. In a patient of mine who had fifteen calculi in his bladder, all the stones were round, about the size and shape of marbles, without any facets. In other cases, again, there may be more facets on one calculus than companion calculi in the bladder. A second stone may occasion two or even three facets on the first, having rolled first to one and then to the other side of it.

Spontaneous Fracture of a Calculus will sometimes occur within the bladder. This has been met with only in uric acid calculi, and may happen to a stone that is single, or to one among many. Civiale suggested that the fracture might be due to the pressure of a hypertrophied bladder, and others have supposed that it might be caused by concussion of one stone against another, but both these theories are without evidence to support them. In the museum of University College is a calculus removed as it were in the act of disintegrating. Apparently by a process of shrinking of the older parts of the stone, fissures have formed concentrically round the nucleus, and the zones thus formed are divided transversely by other fissures. The urine has soaked into these and deposited a small quantity of soft white phosphatic matter, showing that the shrinking and fissuring have occurred before removal. The stone shows great tendency to break up into segments, and has in part done so. Where spontaneous fracture occurs great irritability of the bladder is set up. In some cases the fragments become agglomerated together by the deposit of a quantity of phosphatic matter upon and around them. In other cases, the different fragments may each form the nucleus of a fresh calculus, so that the bladder may afterwards contain numerous concretions.

Physical Characters.—The **Size** of calculi varies from that of a hemp-seed or pin's head to a concretion of immense magnitude. One of the largest with which I am acquainted, is a calculus removed by the high operation by Uytterhoeven of Brussels, which I saw some time ago in his possession, and of which he has been obliging enough to give me a cast; it is pyriform, and measures 19½ inches in its longest circumference, and 12½ inches round at its broadest part, being 6½ inches long, and about 4 wide. In the celebrated case of Sir W. Ogilvie, Cline attempted, but failed, to extract a calculus measuring 16 inches round one axis and 14 round the other. These enormous concretions are happily seldom met with at the present day; the usual size of stones removed by operation being from about one to two inches in the longest diameter, somewhat narrow, and perhaps flattened.

The **Weight** of calculi varies from a few grains to several ounces; the commonest weight is from three drachms to about one ounce, reaching occasionally from three to six ounces; from this they may range upwards until several pounds are reached. Thus, in Cline's case the stone weighed 44 ounces. Deschamps saw one of 51 ounces, and Morand one weighing 6 lbs.: none of these admitted of removal. Sir H. Thompson has successfully removed one weighing 14 ounces, and W. Rivington one weighing 23, which had to be broken up in the bladder. The largest calculi are usually composed of phosphates, in greater part if not in whole. Large and heavy calculi are certainly less frequently met with now than formerly, owing to operations for stone being simpler and less dreaded since the introduction of anæsthetics, and hence practised in an earlier stage of the disease.

The **Hardness** of calculi varies considerably ; the oxalate of lime is the hardest ; the uric acid comes next, and is often very hard, though brittle ; the phosphatic calculi are always comparatively soft.

The **Shape** of calculi presents great variety ; most commonly, however, they have an ovoid figure. Concretions of uric acid and urate of ammonia are generally pretty regularly ovoidal, smooth, and disc-like. Those composed of oxalate of lime are usually somewhat globular or square-shaped, and generally rough, nodulated, or spiculated upon the surface. The phosphatic calculi present often the most irregular outline ; most commonly, it is true, they are ovoid or globular, but are not unfrequently branched, as if moulded to the interior of a sacculated bladder, constricted, or of an hour-glass shape. The cystine calculi are generally tolerably oval and regular in outline.

Position.—Most frequently calculi lie loose in the bladder ; but occasionally they may be fixed, either by being encysted, and then lying in one of the sacculi that have already been described within the walls of the bladder (Figs. 860 and 861) ; or by being impacted in one of the ureters ; or, in other cases by being partly included in villous or malignant growths.

Causes.—Whenever a foreign body of any kind, as a piece of broken catheter, &c., is introduced into the bladder, it will form the nucleus of a calculus, speedily becoming incrusted by calculous phosphatic matter. But the causes of calculi occurring spontaneously are very obscure. There can be little doubt, it is true, that the different forms of concretion are connected with the various general and local conditions that have already been described ; and we may look upon the formation of a calculus as an indication of the existence, in a greater degree of intensity than usual, of the causes which ordinarily give rise to sediments or gravel ; but why, in particular cases, aggregation into a calculous mass takes place, it is impossible to say.

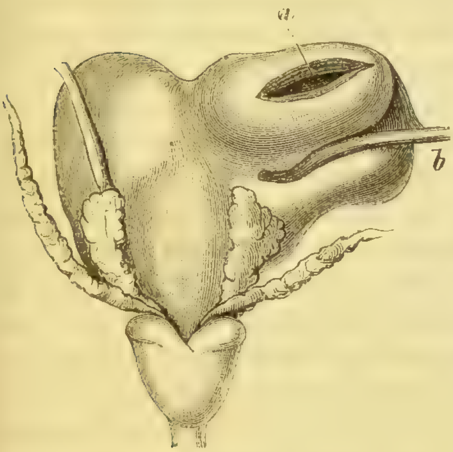


Fig. 860.—Exterior of Bladder, containing an Encysted Calculus at *a* : *b*, Ureter.

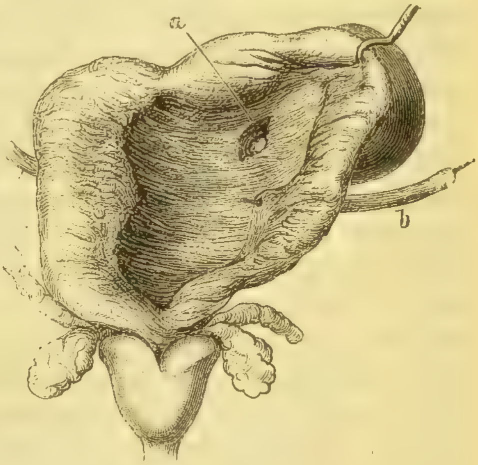


Fig. 861.—Interior of the same Bladder, showing small Orifice leading into Cyst at *a* : *b*, Ureter.

Age exercises considerable influence upon the production of calculi. Stone may occur in the bladder at all periods of life, and even, according to Stahl, be congenital. The greatest number of cases apparently occur during the first two decennial periods ; thus, in the statistics collected by Sir Henry Thompson from the chief hospitals of this country, he shows that one-third of the entire number of cases occurred before seven years of age, and one-half before the thirteenth year is completed. Coulson has collected 2,972 recorded cases of lithotomy from various sources ; of these, 1,466 occurred under the age of ten, 731 from eleven to twenty, 205 from twenty-one to thirty, 264 from thirty-one to fifty, and 306 from fifty-one upwards. These statistics refer entirely to hospital practice. The later statistics published by Thompson, derived from his own practice, public and private, show somewhat different results. Thus, of 812 patients upon whom he has operated, 595 were above fifty. This apparent discrepancy arises from two causes. First, the more extensive statistics are derived from cases operated on chiefly before the days of anæsthetics, when numerous adults died unrelieved rather than face the horrors of lithotomy ; whereas children had little choice in the matter. Diagnosis also was not so perfect at that time, and many small stones in old people escaped detection. Secondly, Thompson's own statistics are chiefly derived from private practice, and it is well known that the children of the rich very rarely suffer from stone ; whereas that disease is very common among those of the poor. The cause of this is not very certain, but some attribute it to insufficiency of milk in the diet.

Sex influences materially the occurrence of stone, which is far more frequent in the male than in the female, in the proportion of about twenty to one of cases requiring operation. This, however, does not represent the exact ratio ; as, owing to the shortness and large size of the urethra in females, many small calculi are voided by them that would be retained in the male.

Locality.—It would appear that *in some parts of the world* calculus is a far more common disease that in others. It is generally more frequently met with in cold than in warm climates. The negro race is remarkably exempt from this affection. It is a singular fact that in some parts of the same country calculous disorders are of far more frequent occurrence than in others. Thus it is well known that the inhabitants of the east coast of England and Scotland are peculiarly liable to these disorders ; and that in Norfolk stone occurs with especial frequency, the mortality from calculus being much higher there in proportion to the population than in any other county of England (Cadge). In America also, it would appear that the inhabitants of certain States are peculiarly liable to this affection ; and I understand that in some districts of Germany the disease may be said to be almost unknown, whilst in others it is of common occurrence. The relative frequency of the kinds of calculus also varies in different countries. H. V. Carter, who has analysed and described upwards of a hundred specimens contained in the museum of the Grant Medical College at Bombay shows that the percentage of calculi with a uric acid or urate of ammonia nucleus is, in India, 56·30, in England, 71·79 ; while that of calculi with a nucleus of oxalate of lime is in India, 38·65, in England, 16·87. The calculi composed purely of oxalate of lime also greatly exceed in number those which consist entirely of uric acid or urate of ammonia. To what these differences are owing it is impossible to say. Peculiarity of race, of constitution, and of diet, with exposure to prevalent dry and cold winds, have all been assigned as reasons for them ; but probably not on very sufficient grounds.

Symptoms.—The symptoms of stone in the bladder vary according as the calculus lies loose or is encysted. Their intensity will depend on the size and shape of the stone, the condition of the bladder, and the constitution of the patient. Most commonly, the severity of the symptoms is in proportion to the magnitude of the calculus. This, however, is not always the case. In a patient whom I once cut, the most intense suffering and repeated attacks of cystitis had been occasioned by a small but sharp-pointed calculus, not weighing more than a drachm; and some years ago I saw a patient in whose bladder five calculi nearly as large as chestnuts, were found after death, though their presence had never been suspected during life by the different Surgeons under whose care he had been for stricture, so little distress had they occasioned. In some cases, the symptoms of stone declare themselves very suddenly; and then the Surgeon finds on examination that the patient has a calculus of some size, which must have been a long time forming without attracting attention. Rough and angular calculi necessarily give rise to more severe symptoms than smooth ones. Phosphatic calculi being deposited almost invariably as a consequence of cystitis with foul urine, are accompanied by much pain and constitutional disturbance.

The symptoms induced by stone are the result of the mechanical irritation produced by the presence of a foreign body in the bladder; they consist of Pain, Increased Frequency in Micturition, occasional Stoppage of the Urine, and Various Morbid Conditions of that Fluid.

The **Pain** in calculus is often the first symptom that attracts attention; it varies greatly in character and degree. It may be experienced not only in the region of the bladder and the perinæum, but may radiate widely in the course of the nerves of the lumbar and sacral plexuses, the patient complaining of a heavy and dragging sensation in the groins, extending down the outside or back of the thighs, and not uncommonly experienced in the soles of the feet. The penis is the seat of a good deal of uneasiness; frequently of a sharp and cutting pain at the end of the glans. This is especially noticed in children, in whom attention is often attracted to the complaint by their constantly squeezing and pulling the organ to relieve the distress they suffer in it. The pain is much increased by any movement by which the stone is jolted about in the bladder, as in driving, riding, or jumping; and is especially severe in those cases in which cystitis occurs. It is always most severe towards the termination of, or immediately after, micturition; as there is then a tendency for the calculus to roll forwards towards the neck of the bladder, where it comes into contact with and is grasped by the most sensitive part of that organ. Hence it is not unfrequent, in cases of calculus in children, to find that the little patient instinctively lies upon his back or side whilst passing urine, and thus escapes much of the agony that he would otherwise suffer. In adults in whom the prostate happens to be enlarged, the calculus usually lies in a depression behind this gland; and hence, being prevented from being squeezed by the neck of the bladder in consequence of imperfect contraction, occasions less suffering than in other cases.

In consequence of the irritation of the stone occasioning chronic inflammation of the vesical mucous membrane, there is an **Increased Frequency of Micturition,** more by day than at night. The urine is passed in small quantities at a time, usually contains some mucus or pus, and is occasionally tinged with blood, or loaded with thick vesical mucus. But in many cases the urine remains remarkably clear, and free from marked admixtures throughout. Albumen from blood or pus is commonly present, and in the later stages when the kidney becomes affected, it may come from that source also. The presence of blood in the urine is often one of the earliest signs of stone in the bladder, and in children especially, should lead to the suspicion of calculus. It may be in large quantities, and may continue for many weeks, especially in the earlier stages. The urine may then clear as the bladder becomes accustomed to the presence of the stone, and the blood may reappear only under the influence of active movement, or of any cause of increased irritation of the organ. But it is important to observe that the quantity of albumen, as shown by boiling the urine, will be very great whenever even a trace of blood is present. It very rarely happens that a stone has existed for any time, without the urine becoming occasionally streaked or tinged by blood.

An occasional **Stoppage in the flow of Urine** before the bladder is emptied owing to the stone being impelled against its neck, and thus blocking up the urethra is a common symptom in children, but very rare in adults. On the patient lying on his back or on his side, the stream flows again, the situation of the calculus being changed.

As a result of the straining and general irritation about the genito-urinary organs, **Prolapsus of the Anus,** accompanied by **Tenesmus,** is by no means uncommon, especially in children; and in some cases there is very troublesome **Priapism.**

Stone in Elderly Men often gives rise to but feebly marked symptoms. This fact has been specially called attention to by Sir Henry Thompson. He states as the result of his unrivalled experience, that partly from diminished sensibility of the bladder in elderly men, and partly from the frequency with which a moderately enlarged prostate may mask the symptoms, many a man may and does carry a uric acid calculus for three or four years with little or no inconvenience, so that the presence of the stone may easily be overlooked till it attains such a size as to make its removal a serious and possibly a dangerous operation. In these cases the symptoms he regards as most characteristic, are slight pricking or smarting at and near the end of the penis, often but not invariably felt during and after the close of micturition, and increased frequency of micturition, less felt at night, and more manifest in the day, especially during exercise; but if the patient lead a very quiet life this symptom may be wanting. Florid blood in small quantities may appear after more violent exercise, or jolting from any cause. The urine is acid and clear, and often deposits lithates. By sounding the patient when these symptoms are present, a small stone may often be detected and removed without appreciable risk.

Stone in Children.—The symptoms in children present few peculiarities, except that the patient is often unable clearly to describe what he feels. Pain on movement is indicated by the child's disinclination to play or run about. Screaming or crying after micturition is common; the irritation of the stone often leads to incontinence at night, and frequent wetting of the clothes during the day, often causing excoriation of the thighs. Constant handling of the penis and pulling of the foreskin till it seems in some cases to be actually lengthened, are also important signs. With these, straining, with prolapsus of the rectum during micturition, is usually present, and sudden stoppage of the stream during micturition is not uncommon. Whenever a child presents these symptoms, he should be at once sounded. If no stone be found, the child must be examined for worms, the irritation of which may give rise to symptoms closely resembling those of stone. A tight phimosis will also cause symptoms distinguishable from stone only by sounding.

Encysted Calculus.—When a stone is *encysted*, those symptoms that depend upon its being loose and rolling about in the bladder, are necessarily absent; thus there is no stoppage of the urine, this fluid is seldom bloody, and the pain is not materially increased by jolts and rough movement; though there are weight and pain in the usual situations, and increased frequency of micturition from the pressure and irritation of the calculus.

PHYSICAL DIAGNOSIS OF STONE.—The existence of stone is finally determined by **Sounding the Bladder.**

A **Sound** is a solid steel instrument shaped like a catheter, but shorter in the curve (Fig. 862), so that it may thoroughly explore all parts of the bladder, especially those behind the prostate. It should have a wide and smooth steel handle, and be slightly bulbous. Sir H. Thompson prefers a hollow sound with a round handle, and a short beak bent at a sharp curve like a lithotrite. The operation of sounding is conducted as follows. The patient lies upon his back with his buttocks well raised on a pillow; a full-sized sound, well-oiled and warmed, is then passed into the bladder, which should, if the patient can retain it, be allowed to contain three or four ounces of urine. The Surgeon then using his left hand, or crossing over to the patient's right side, whichever he finds most convenient, carefully directs the beak of the instrument towards the neck of the bladder, turning it from right to left over the whole of that region; he next draws it forward on one side as far as the neck, tapping, as it were, gently with its beak; he repeats the same manœuvre on the other side; and, lastly, by raising the handle directs the end of the instrument into the lower fundus, which he carefully explores. Usually the stone is readily detected by these manœuvres, and its position in the bladder will often be dependent upon, and may to a certain extent be

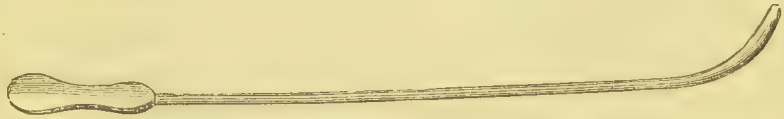


Fig. 862.—Sound for Examining Bladder.

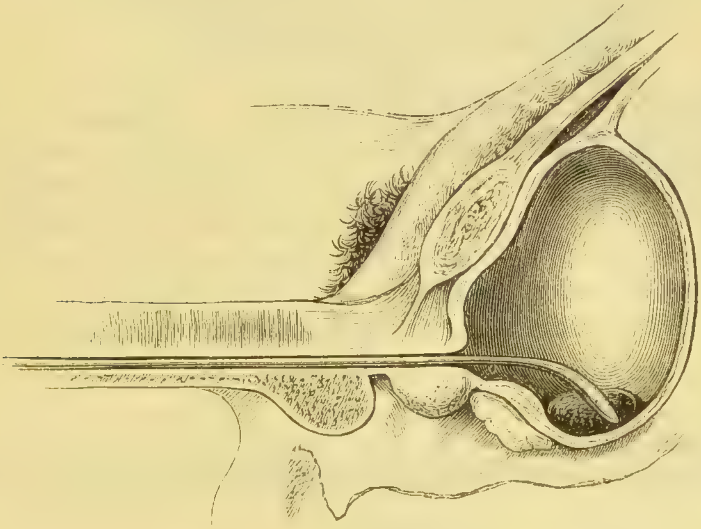


Fig. 863.—Sounding for Stone behind Prostate.

taken as an approximative indication of, its size. Thus, when moderately large, it will usually be found lying to one side, most generally the right, of the neck of the bladder; when small, it will be placed towards the fundus, near the orifice of one or other ureter. These then are the situations in which the Surgeon should first seek for a stone, and in which he will generally find it when present. Should it not be met with there, the chances are, more especially if the patient be elderly, that it will be found in a pouch behind the prostate, where it may be detected by depressing the handle and then turning the beak of the sound downwards (Fig. 863). Should the Surgeon not detect the calculus in any of these situations, he depresses the handle between the thighs, and tilts up the beak so as to examine the pubic portion of the organ (Fig. 864). In the event of his not meeting with a stone, he may explore the bladder, first on one side, then on the other. Should the rational symptoms of stone be well marked, though no calculus be struck, the Surgeon must not give a decided opinion in the negative after the first exploration, but should examine the patient again a few days later, with the bladder in a different state as to its contents. In making this second examination, I have found it of great service to use a hollow steel sound, by which the organ can be injected or emptied at pleasure (Fig. 865). The patient should on this occasion have his bladder injected through such an instrument as this, with four or six ounces of tepid water, so as to distend the organ slightly, and prevent the folds of mucous membrane from overlapping any concretion that may exist in it. Its interior is then carefully explored in the way already described; and, if the stone cannot then be detected, the contents of the bladder are gradually allowed to escape through the sound, and the patient is desired to stand up whilst the exploration is being proceeded with. In this way, by examining a patient in

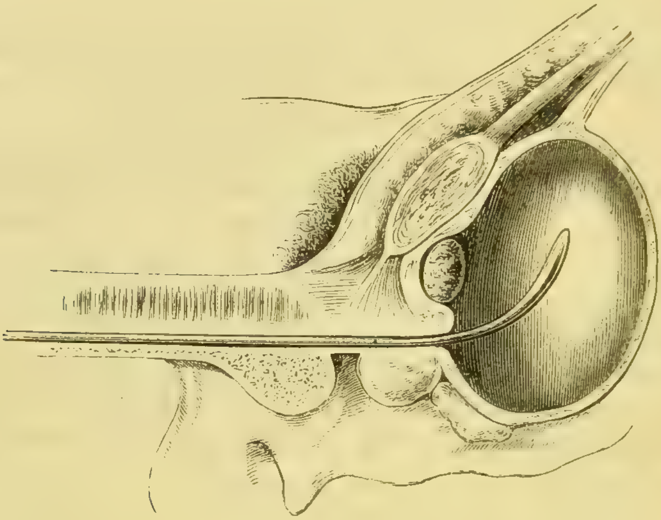


Fig. 864.—Sounding for Stone above Pubes.

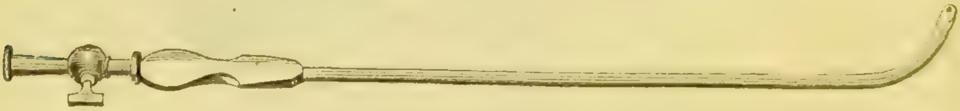


Fig. 865.—Hollow Sound.

different positions and in different conditions of the bladder as to capacity, a calculus is sure to be detected if one exist. A lithotrite may occasionally be advantageously used as a sound for the detection of small calculi lying behind the prostate, a situation more readily reached by its short beak than by an instrument of larger curve. These examinations must not, however, be too protracted. When a stone is struck by the sound, there is not only a characteristic and distinct shock communicated to the instrument, but a tolerably loud click is given, which can be heard by the bystanders, and frequently by the patient, as well as by the Surgeon.

Rough sounding is doubly injurious. It injures the bladder and fails to find the stone. The stone is often missed in sounding, especially when small, by being carried to and fro as the urine and the bladder are moved backwards and forwards by rough manipulation. It will be found, if the parts are allowed to become quiescent, that the stone falls to the bottom behind the prostate, where it will be found by a gentle tap of the sound.

By conducting the sounding properly, the Surgeon may usually ascertain not only the existence of a stone, but its size and hardness; whether it be single, if it be encysted, and the general state of the bladder; with all of which points it is of importance that he should be acquainted before undertaking any operation. A good deal of this information may be elicited by the ordinary sound, but some of the points can be accurately determined only by sounding with the lithotrite.

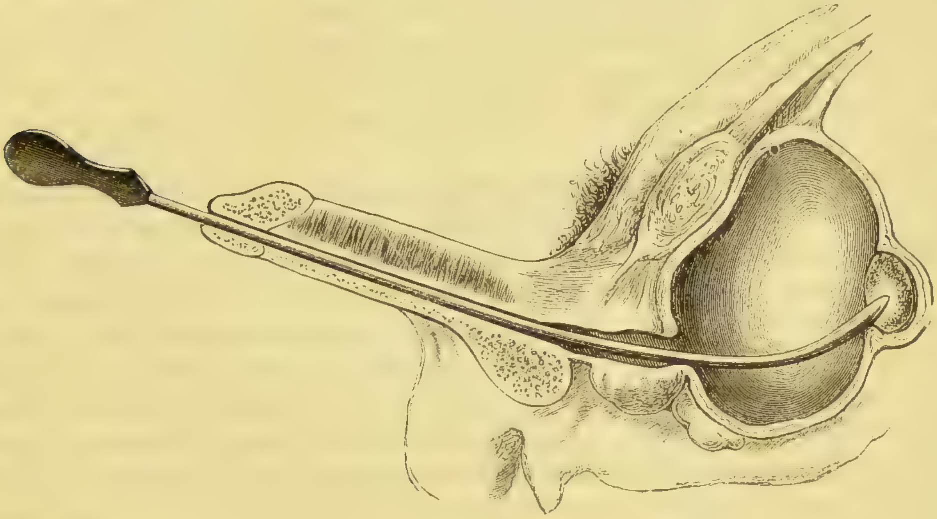


Fig. 866.—Sounding for Encysted Calculus.

The *hardness* of the stone may usually be judged of by the more or less clear ringing character of the click; a uric acid or oxalate of lime calculus giving a sharper sound than a phosphatic concretion.

A calculus may generally be known to be *encysted* if the sound strike it at times, but not at others (Fig. 866); if the stone always appear to be fixed in one situation; and if the beak of the instrument cannot be made to pass round it, so as to isolate it, but a kind of tumour projecting through the walls of the bladder is felt, around or on one side of the point where the calculus is struck.

The fasciculated, roughened, and sacculated *condition of the bladder* may generally be detected by the way in which the beak of the instrument grates and rubs over the organ.

The *size* of the calculus is best determined by a lithotrite. It is true that a Surgeon may sometimes come to a decision as to the bulk of a calculus, by observing the extent of surface along which the sound is in contact with the stone, as the instrument is being withdrawn. But only a very rough guess can be made in this way; and I have frequently seen very experienced Surgeons deceived, mistaking perhaps several small stones lying together for one large one. By introducing a lithotrite and seizing the calculus gently between its blades, a correct estimate of its size may always be arrived at.

In order to determine that *several calculi* exist in the bladder, it is sometimes sufficient for the Surgeon to feel that the beak of the sound comes in contact with a stone on each side of the organ, or that it can be distinctly insinuated between two concretions. In some cases, however, these points cannot clearly be made out ; and then the Surgeon, introducing a lithotrite and seizing the first calculus with which he meets, should hold this between the blades of the instrument, and whilst it is so fixed move it and the lithotrite from side to side ; when, if a click be heard and felt, he may be sure of the existence of another stone.

Sounding is by no means free from danger, more especially if done roughly, or in patients who have chronic kidney-disease. In the first case it may give rise to cystitis or profuse and continuous hæmorrhage ; in the second, to rigors and suppression of urine.

Errors in Sounding occasionally occur. The Surgeon may mistake a hardened and fasciculated bladder, having its ridges perhaps incrusted with phosphatic matter for a calculus ; this is especially apt to happen in children. In these cases, however, the mistake may usually be guarded against by the absence of a distinct click, though a rough grating sensation be experienced, and by the Surgeon being unable to isolate a stone. Yet the difficulty in some cases is great : Velpeau stated that he was acquainted with four instances, and S. Cooper with seven, in which patients had been cut and no calculus found ; and when we reflect that these accidents have happened to such men as Cheselden, who on three occasions cut a patient and found no stone, to Crosse, to Roux, and Dupuytren, it is easy to understand that in some cases the difficulty of coming to a correct decision must be very great.

Examination of the Bladder by Manipulation can be easily carried out in children. The patient is fully anæsthetized ; the Surgeon then passes one finger into the rectum and presses firmly with the other hand above the pubes. If a stone be present it can be clearly felt by the finger in the rectum and its size ascertained. In adults this mode of examination is of course impossible if there be much abdominal fat or any enlargement of the prostate, and even in the absence of these conditions it is very uncertain, as the finger does not reach far enough up to grasp the stone.

Stone in Women.—In women the symptoms of stone closely resemble those met with in men, and the detection of the calculus is usually very easy, owing to the shortness of the canal and the facility with which the stone may be tilted up by introducing the fingers of the left hand into the vagina.

Pathological Changes induced by Calculus.—After a stone has existed for some time in the bladder, it induces serious pathological changes in the whole of the urinary apparatus. The *prostate* not unfrequently becomes somewhat enlarged and irritable, in consequence of which a kind of pouch is formed behind it, in which the calculus is apt to lodge. The most important changes, however, take place in the bladder and kidneys. The *bladder* becomes extremely sensitive, especially about its neck, and is consequently unable to contain as much urine as usual; hence it becomes contracted. In some rare instances, however, as will be more especially noticed when we come to speak of lithotrity, it falls into an atonic condition, and then is apt to become rather largely dilated. The mucous membrane is commonly a good deal inflamed and irritated by the presence of the calculus; and the muscular coat becomes thickened and hypertrophied, so as to give it a very fasciculated appearance. Sacculi occasionally form, containing sabulous matter and fetid pus or urine, and in some cases lodging a concretion, which then constitutes an encysted calculus lying altogether outside the cavity of the bladder, with which it merely communicates by a very narrow aperture, as in Figs. 860 and 861, representing a case that was under my care, and which is fully described in the Journals for March, 1853. The *kidneys* are often congested, frequently in a state of chronic or subacute interstitial inflammation, and ultimately become the seat of such structural changes as are incompatible with life. When death occurs as the consequence of stone, the patient usually sinks, worn out by protracted suffering and kidney-disease.

LITHOTOMY.

It is not my intention to enter into the general history of lithotomy, an operation that has been practised from the earliest ages; nor to give a stretch of the gradual modifications that have at various times been introduced, from the rude attempts of the Greek and Roman Surgeons to the barbarous and unscientific procedures adopted by the itinerant operators after the revival of letters. For all this, I would refer the reader to the classical works of Deschamps and of John Bell. The operation, most frequently practised in this country, is essentially that introduced by Cheselden, and modified more or less according to the views of particular Surgeons. Though Surgeons generally are agreed upon the great principles involved in it, they differ in their modes of carrying these out; thus the direction and extent of the incisions and the instruments employed have been much varied to suit the tastes and views of particular operators. But, although I look upon Cheselden's operation, as modified and practised by Liston, as being on the whole the simplest and safest mode of cutting for stone as yet introduced, there can be no doubt that recourse may occasionally be had with advantage to other methods instead of it. Indeed, there is no operation that requires to be considered from so many and such different points of view as lithotomy. The size, shape, and position of the stone, the age and constitution of the patient, all render it desirable, and indeed necessary, to modify the method of operating. Hence, a Surgeon should not be too exclusively wedded to one plan, but should adopt one or other of the methods about to be described, according to the exigencies of the particular case before him.

Instruments, &c.—The table for operating must be firm and of convenient height, so that when the Surgeon sits on a rather low stool the patient's nates will be on a level with his breast; a few blankets doubled should be laid upon the table, and covered by a piece of mackintosh cloth hanging over the end;

and a tray of sawdust placed under it on the floor. The instruments necessary are the following :—a pair of lithotomy-tapes, a sharp and probe-pointed scalpel, a staff, forceps, and scoops of various sizes, and a tube. To these may be added a searcher, and a brass injecting syringe.

The *tapes* should be of coarse flannel, about three yards long, by three inches broad.

An infinite amount of ingenuity has been expended in giving variety to the shape of the *knives* used for opening the deeper portions of the urethra and neck of the bladder in lithotomy. Instruments of this kind, straight-edged and shouldered, beaked and probe-ended in every possible way, have been devised ; and each has had its special advocate, but has seldom been adopted in practice by any except its inventor. All these modifications of the ordinary scapel are, to say the least, useless ; some, perhaps, actually dangerous. They simply seek to supply by mechanical means that safety in the deeper incisions which may as readily be secured by a broad-bladed, straight-backed scalpel, if properly guided by a hand that is ordinarily skilful.

Fig. 867.—Lithotomy Scalpel.

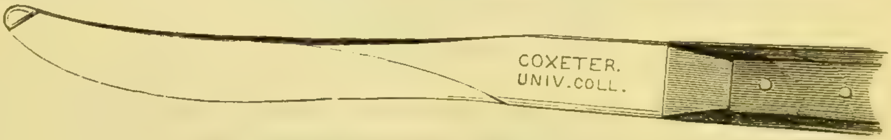


Fig. 868.—Probe-pointed Lithotomy knife.

The cutting gorget, formerly much in vogue, is all but universally discarded by the modern lithotomist as a most dangerous tool.

The *scalpel* for the adult may be of the size and the shape represented (Fig. 867) ; for children, it may be made a little smaller. A *probe-pointed lithotomy knife* of the size and shape here represented should also be at hand (Fig. 868).

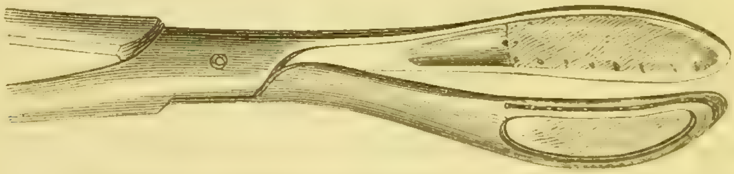


Fig. 869.—Open-bladed Lithotomy-forceps, lined with linen.

The *staff* should have a deep groove on its left side, occupying nearly one-third of the instrument ; it should be well curved, of as large a size as the urethra will admit, and have a roughened handle (Fig. 874).

The *forceps* must not be too heavy, but should be of a good length in the handles, and have the joint well set back ; the inside of the blades, as recommended by Liston, should be lined with linen to prevent the stone from slipping (Fig. 870). Coxeter has made them with open blades, but lined with linen as heretofore (Fig. 869) ; in this way, as there is less metal, the weight is diminished, and the diameter of the instrument with a stone in its grasp is materially lessened. The ordinary forceps are straight, but it is advantageous to be provided with some that are curved (Fig. 871). The handles should be made with a loop on one side and a ring on the other; the ring for the reception of the thumb should be placed somewhat obliquely. The *scoops* of different sizes, and curved, can most conveniently be used when fixed in roughened handles (Figs. 872 and 873). The *tube* should be of gum-elastic, well rounded at the end, and provided with silver rings, and may be petticoated. The *searcher* is a slightly curved sound, having a bulbous extremity (Fig. 875). The *syringe* should be provided with Gross's ball nozzle, which propels a reversed current.

In describing the operation of lithotomy, we shall first of all examine *seriatim* the different steps of an operation that presents no unusual complication or difficulty; we shall then consider the difficulties that may be met with, the accidents that may occur during the operation, and the principal sources of danger and the causes of death after its performance.

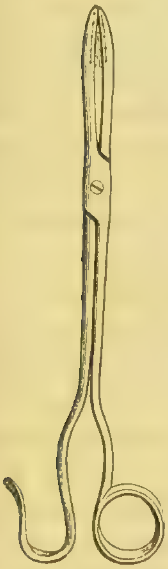


Fig. 870.—Forceps.

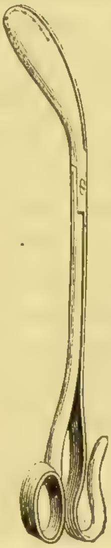


Fig. 871.—Curved Forceps.

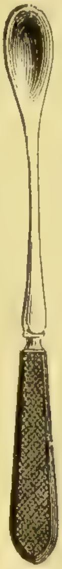


Fig. 872.—Scoop in Handle.

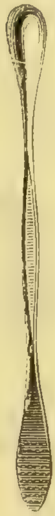


Fig. 873 Scoop.

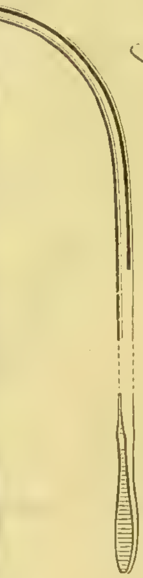


Fig. 874. Staff.

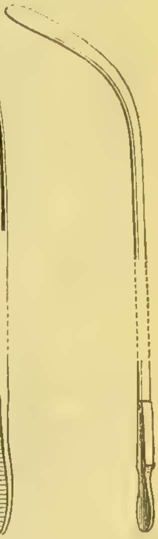


Fig. 875.—Searcher.

Preparation of the Patient.—Before subjecting a patient to operation, his general health must be properly attended to; and, indeed, if we find the constitution much broken by prolonged suffering, the bladder or kidneys seriously diseased, as indicated by the existence of pus or albumen in large quantity in his urine, and by the presence of the symptoms of interstitial nephritis (pp. 959—963), it will be wise to postpone the operation for a time, or perhaps even to abandon it altogether. There are few conditions in which a Surgeon is placed, that test his moral courage more severely than to have to refuse to operate on a patient for stone, and thus allow him to die unrelieved. For a Surgeon to do this, unmoved by the entreaties of the patient and of his friends, requires no little self-reliance. Yet, when the patient is greatly emaciated, his constitution broken down, and his kidneys evidently much diseased, lithotomy would be attended by an inevitably and rapidly fatal result, and the performance of an operation would be a useless act of cruelty. Supposing, however, that the stone is of moderate size, that evidence of renal disease is absent or slight, that there is no visceral complication to prevent the performance of the operation, and that the patient's health is in a tolerably good state, it will be necessary to subject him only to proper preparative treatment for a short time, so as to allay or remove irritability of the urinary organs before proceeding with it. With this view he should be kept as quiet as possible for about a week or ten days preceding the operation: his diet should be properly regulated, but not too low; the pain should be lessened by the administration of opiates or henbane, and the bowels properly relieved. On the day preceding the operation, a dose of castor-oil or some other aperient should be administered; and on the morning of the operation the rectum must be emptied by means of an enema.

Lateral Operation.—All the urine contained in the bladder having been drawn off, that organ should be filled by the injection of about six or eight ounces of tepid water, in order to steady it and to facilitate the seizure and extraction of the stone. After the anæsthetic has been administered, the Surgeon should introduce a full-sized staff, which he uses as a sound, in order to feel for the calculus. If he detects it, he proceeds with the operation; if he cannot detect it, the operation must be deferred, for it is an imperative rule in surgery that lithotomy should never be performed unless the stone can be felt *with the staff* immediately before cutting, as the point of this, though apparently in the bladder, might be actually engaged in a false passage. The stone, then, having been felt, the patient is to be firmly tied up. This is done by making a clove-hitch on the tape, and passing it round the wrist, after which the ends of the tape are passed round the instep and hand in a figure-of-8, as in Fig. 876. Some Surgeons prefer leather anklets, which are attached to collars round the wrists by hooks; but these take longer to apply, and have no particular advantage over the tapes. The patient is now brought to the end of the table, so that his nates project beyond it, where he is to be securely held on each side by an assistant, who grasps the foot in his hand, places the patient's knee under his arm, and draws the limb well aside, so that the perinæum may be fairly exposed. It is desirable that the perinæum be thus fully exposed to the Surgeon. In a patient, however, on whom I once operated, this could not be done, owing to the left hip being stiffened by chronic rheumatic arthritis: but I did not experience any particular difficulty in the operation, though somewhat inconvenienced by the position of the limb. The Surgeon then, seating himself before the patient, shaves the perinæum—if this have not already been done—and introduces his finger into the rectum. This is done with three objects, first, to ascertain the depth of the perinæum by feeling for the apex of the prostate; secondly, to make sure that the rectum is empty;

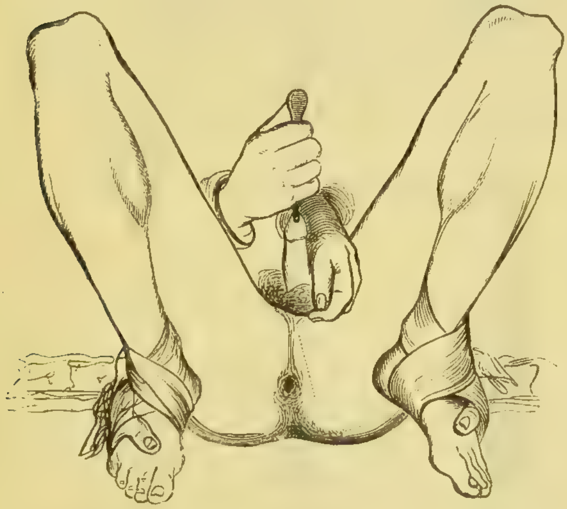


Fig. 876.—Position of Patient and Line of Incision in Lateral Lithotomy.

and thirdly, to cause a contraction of the gut, which will keep it out of the way during the first incision. The staff must then be given into the charge of a trusty assistant, who stands on the patient's left, and who raises and draws aside the scrotum with the left hand whilst he holds the staff in the right (Fig. 876).

The Surgeon then sees that the staff is held in the way in which he prefers it. There are two ways in which it may be held; it may either be drawn well up into the arch of the pubes, or it may be pushed somewhat down, and slightly turned towards the left of the perinæum. Liston always employed the first method, which I certainly think is the best, as it tends to increase the space between the urethra and the rectum, and lessens the danger of wounding the gut, which more than counterbalances the advantage of the other method—that of bringing the membranous portion of the urethra nearer to the surface.

The external incision is made by entering the knife in the raphe of the perinæum, one inch and a half above the anus, and carrying it downwards and outwards, until it reaches a point that is just below the anus, but about one-third nearer to the tuberosity of the ischium than to the margin of the anal aperture (Fig. 876). It is useless to prolong the incision beyond this, as any freer division of the superficial structures of the perinæum cannot facilitate the extraction of the stone; but it must occupy the extent indicated, otherwise considerable difficulty may be experienced in the later steps of the operation. The depth to which this incision should be carried must vary according to the obesity of the subject; usually from about three-quarters of an inch to an inch, but not so deeply above as below. By this incision the skin, superficial fascia, subcutaneous fat, and inferior hæmorrhoidal vessels, are divided. After it is completed, the knife is again introduced a little below the upper part of the wound, and the blade is run lightly downwards over any resisting structures; the left fore-finger being placed at the middle of the wound, so as to protect the rectum. In this way the triangular space is opened between the accelerator urinæ, the erector penis, and the transversalis perinæi muscles; and as the knife is carried downwards, the last-named muscle, the transversalis perinæi artery and some areolar tissue are cut through. The lower border of the triangular ligament also is notched so as to open up the space between the two layers of the ligament, in which the membranous part of the urethra lies. The knife is then withdrawn, and the left index-finger is pushed deeply into this space until the edge of the nail is lodged in the groove

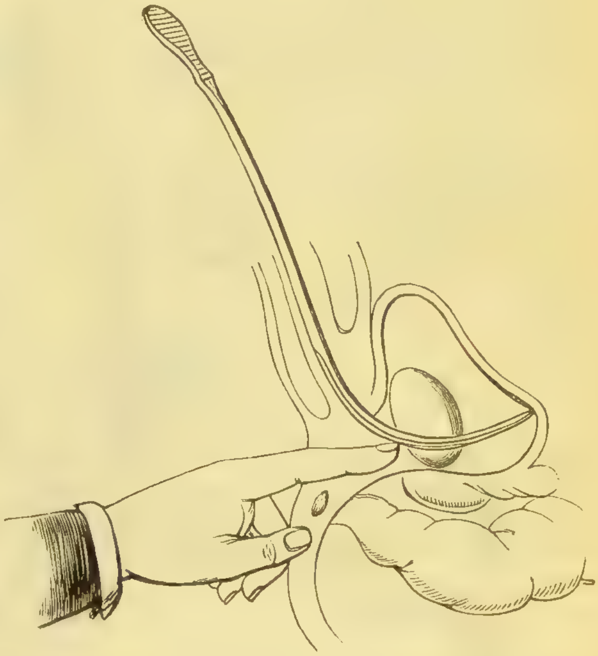


Fig. 877.—Lateral Lithotomy: Finger-nail in Groove of the Staff.

of the staff (Fig. 877), which can be felt just anterior to the prostate, thinly covered by the membranous portion of the urethra, the constrictor urethræ, and the deep transverse muscle. The point of the knife is then pushed through the urethra at its membranous part into the groove of the staff, above the index-finger, which protects and presses to the right the rectum lying beneath it (Figs. 878 and 879).

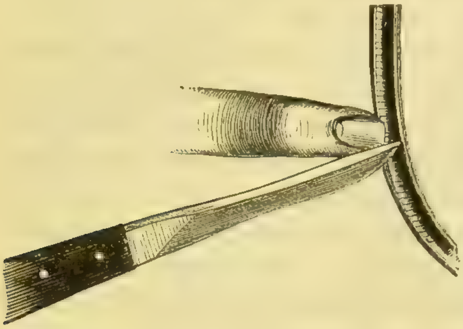


Fig. 878.—Knife in Groove of Staff.

When the knife is felt to be well lodged in the groove, its handle is slightly depressed, so that the point may be raised; at the same time the blade should be somewhat lateralized so that its side lies parallel to the ramus of the ischium. If the edge be turned too directly downwards towards the mesial line, the rectum may be wounded; and if it be directed too much outwards the internal pudic artery will be endangered (Fig. 880); hence the mid course is the proper one.

The Surgeon, keeping the knife steadily in this position, and pressing the point firmly against the side of the groove of the staff, which he must never for a moment lose, pushes it forwards, dividing the membranous part of the urethra, the anterior part of the prostate gland and the sheath enclosing it, and a few fibres of the levator ani (levator prostatæ), and thus makes an entry into the bladder (Fig. 879); he then withdraws the knife, keeping its back

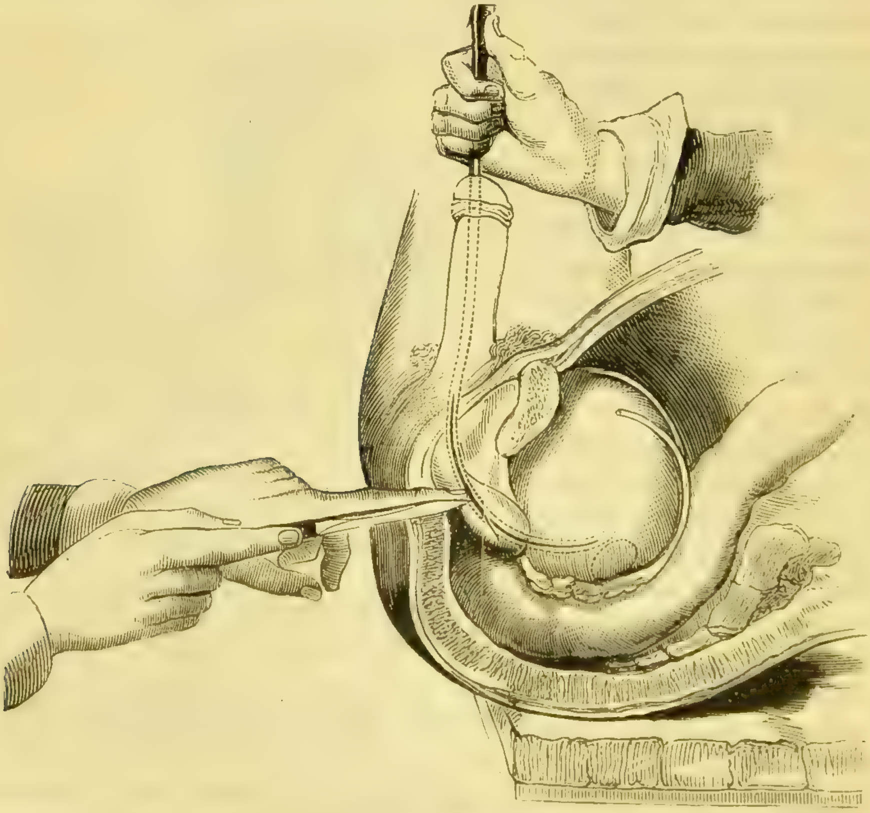


Fig. 879.—Second Stage of Lithotomy.

against the staff, so as not to enlarge the extent of the incision in the prostate. Through this, and along the staff, he then pushes his left index-finger until it reaches the bladder, when he endeavours to feel the calculus with its tip. Should his finger be short, the perinæum deep, or the prostate enlarged, he may be unable to reach the bladder in this way; and must then introduce a blunt gorget, as recommended by Cheselden and Martineau, in order to dilate the aperture in the prostate. If he use his finger for this purpose, he gives it a twist or two after passing it through the prostate, so as to enlarge the aperture through which it is entered. Having made sure that it is in the bladder, and having, if possible, felt the stone, he directs the assistant to withdraw the staff from the urethra.

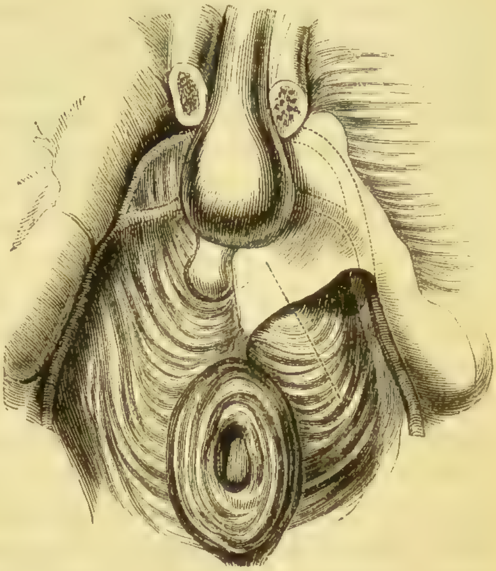


Fig. 880.—Arteries of Perinæum and Deep Fascia.

Here let us pause, and examine the principal points in these the first and second stages of the operation. It will be observed that, in accordance with the best authorities upon this subject, and with my own experience, I have recommended the external incision to be free, the rectum to be protected by the left index-finger, the knife to be lateralized during and after the opening of the urethra, and the deep incision to be limited.

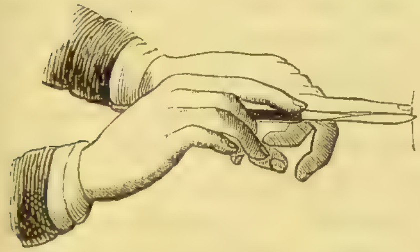


Fig. 881.—Position of Hand and Knife (Fergusson).

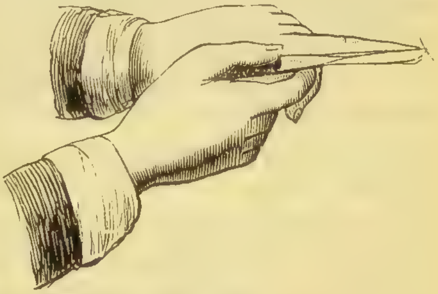


Fig. 882.—Position of Hand and Knife (Liston).

1. The **Position of the Knife** must be carefully attended to, especially during the deep or second incision. At this stage of the operation the edge should be *lateralized;* that is, directed about midway between the horizontal and perpendicular positions, so that the surface of the blade lies nearly parallel to the ramus of the ischium. The manner of holding the knife has been much discussed, and necessarily and naturally varies with different Surgeons. I believe it signifies little how the handle of the instrument is held between the

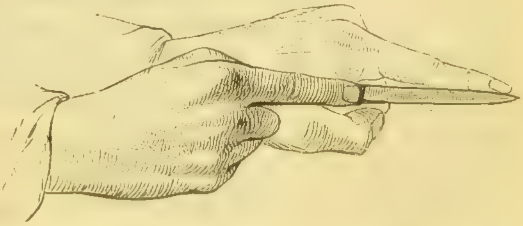


Fig. 883.—Position of Hand and Knife (Author).

Surgeon's fingers, provided the edge be never turned upwards, but be always kept well lateralized, with the point steadily pressed into the groove of the staff. If a Surgeon know what he is about, he may safely hold his knife as best suits his own convenience. In the first incision, most operators, I believe, hold the knife *under* the hand, as represented in Fig. 881 ; a position which that excellent lithotomist and accomplished Surgeon, Fergusson, preserved throughout the operation. Liston, in the early part of his career, appears to have held the knife, in the second stage of the operation, *above* the hand ; and in all the representations, published as well as unpublished, that he has left of his operation, he has depicted the knife and hands in the position shown in Fig. 882 ; which, in the last edition of his *Practical Surgery*, he describes as a correct sketch of "the position of the hands and knife" at the commencement of the second stage of the operation. There can be no doubt, however, as Fergusson has pointed out, that in actual practice, at least after his first few years as an operator, he held the knife under the hand, with the index-finger upon the side or the back of the blade.

For my own part, I believe that every Surgeon will hold the knife in the way which he finds most convenient, and, as it were, natural to him. If any rules can be laid down on this point, I should say that, in operating on a child, or on an adult with a shallow perinæum, the knife is most conveniently held as presented in Fig. 881. But if the patient be fat, and the perinæum deep, then I think that it is a question whether greater steadiness may not sometimes be secured by holding the knife somewhat in the manner of a gorget, with the index-finger perhaps a little more upon the side of the handle (Figs. 883 and 879) ; in this way the point is firmly pressed into the groove of the staff, out of which it cannot slip, as it is secured and supported by the index-finger being somewhat under it. The section of the prostate is thus made by a steady push or thrust of the knife forwards, and not by any cutting movement downwards. No danger can result in the deep incision from pushing the point of the knife up into the groove of the staff ; but there is great danger of missing the bladder, and entering the recto-vesical space, if it be at all depressed and the handle raised, though this cannot always be avoided if the staff be pushed deeply into the bladder. It may happen that the knife will not run readily along the groove, if its blade form too small an angle with the part of the staff with which it is in contact. The hand must then be slightly raised and depressed again as the knife glides along the curve of the staff into the bladder, so that the point may be kept well in the groove, and all risk of slipping out avoided.

2. The **Incision into the Prostate** must be at least of sufficient size to admit the tip of the forefinger readily. The extent to which it should be carried has been the subject of much discussion, and of wide diversity of opinion ; John Bell advising that the incision should reach backwards to the bladder, and Scarpa, that it should not exceed five lines in adults and two in children. The danger, however, it must be borne in mind, does not consist in the section of the prostate itself—which is in reality a structure of but little importance—but in cutting beyond it to such an extent as to open up the loose areolar tissue surrounding the bladder, which would expose the patient to the danger of urinary extravasation and diffuse inflammation.

It was formerly supposed by some Surgeons that a stone of moderate size could be extracted through the prostate without tearing the fibrous capsule of the gland derived from the recto-vesical fascia, which was asserted to remain uninjured, and to prevent infiltration of urine into the surrounding parts. Experiment on the dead body, and the *post-mortem* examination of those who died after lithotomy, clearly demonstrated the fallacy of these views. No stone of one inch in diameter can be removed through a healthy prostate without dividing the gland and its capsule for a considerable part of their length, and if the calculus be of considerable size, the rent will be found to extend backwards in the floor of the bladder, some way towards the left ureter. The danger of urinary infiltration is not in the external parts of the wound, but in the loose subperitoneal tissue; and that distinguished anatomist, Ellis, taught many years ago that the separation between the cavity of the pelvis and the external parts in which a lithotomy wound can be safely made is not the sheath of the prostate but the lateral and anterior true ligaments of the bladder, or in other words, the recto-vesical fascia. Hence the incision may be safely carried through the whole length of the lower and outer side of the prostate up to the very neck of the bladder, provided it do not pass beyond the attachment of the lateral ligament, and so open up the loose subperitoneal tissue around this viscus.

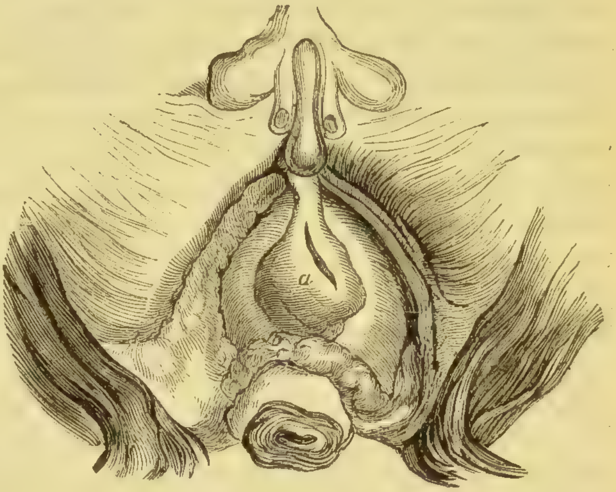


Fig. 884.—Incision in Prostate.

There are, however, other dangers besides extravasation of urine that may arise from too free use of the knife in the deeper parts of the wound, especially hæmorrhage from the venous plexus surrounding the prostate and wound of the rectum. For these reasons I prefer to incise the prostate to a moderate extent, enlarging the aperture by stretching with the forefinger.

In the section of the prostate, then, two points have specially to be attended to: one is, that the knife in entering be not pushed forwards at too great an angle with the staff, so as to cut widely; and the other is, that in its withdrawal the blade be kept steadily in contact with the staff. Indeed, I believe that there is more danger of doing mischief in the withdrawal than in the entry of the knife; for, if it leave the staff for a moment, all guide is lost, and the edge may sweep downwards through the base of the prostate and the neck of the bladder. As the knife is withdrawn, the left index-finger is pushed forwards into the aperture in the prostate, which is then dilated by its pressure to a sufficient extent for the introduction of the forceps, which are slipped in as the finger is withdrawn, and for the extraction of the stone. This part of the operation may very conveniently be performed, as was usually done by Liston, at the moment when the Surgeon is stooping down, engaged in selecting his forceps. The dilatation of the prostate is readily effected; for this structure, though dense, is friable, and breaks down easily under somewhat forcible pressure with the finger. In this way, by a mere notching of the prostate,—by a moderate section of its apex, followed by simple dilatation with the finger,—sufficient space will be obtained for the extraction of all moderate-sized calculi, without the employment of any violence, or the infliction of any bruising upon the tissues.

But another obstacle exists which will prevent the dilatation of the neck of the bladder to any very material extent, without an amount of bruising, or laceration, or even rupture that would probably prove fatal to the patient. This obstacle consists of a firm resisting tissue, which has been described by Tyrrell as "an elastic ring," surrounding the neck of the bladder; by Liston as "a fibrous or ligamentous band surrounding the orifice of the bladder, into which the muscular fibres of the organ are inserted." If this ring or band be ruptured, either by the finger or by the expansion of the forceps, fatal consequences will ensue; but if it be divided, the other tissues, as Liston observes, will yield to an inconceivable extent, without injury to the recto-vesical fascia. The division of this ring must be practised only to a very limited extent. I believe that it is always effected in the act of pushing the scalpel inwards into the bladder; a mere notching of the fibres of the ring, indeed, is sufficient to allow the requisite expansion to take place when pressure is applied.

In thus describing the mode of incising the prostate and neck of the bladder, I have, generally, used the term "dilatation;" and I believe that, by a simple process of dilatation or expansion of these parts, and without any violence whatever, small calculi under an inch in diameter may be extracted. In fact, for the removal of such stones, no force whatever is required, either in opening up the prostate or in withdrawing the calculus. But, in removing stones of greater magnitude than this, I believe that the process of expansion of the prostate and neck of the bladder, whether effected by the finger, by a blunt gorget, or by the opening up of the blades of the forceps, is a process of laceration rather than of dilatation, as I have frequently had occasion to observe in experiments on this point made on the dead subject. If this laceration be, however, confined to the substance of the prostate, and do not extend through the lateral ligament of the bladder, and into the subperitoneal tissue, no harm results. It is difficult, with ordinary force, to lacerate the dense ligament. This structure, therefore, remains as a firm unbroken barrier between the pelvic areolar tissue and the external wound, preventing the possibility of the infiltration of urine into the subperitoneal areolar tissue, and lessening materially the chance of diffuse inflammation. But if, in the withdrawal of the stone, or by an undue expansion of the blades of the forceps, the Surgeon feel a sudden giving way of a tense annular structure, he may be sure that the lateral ligament has been torn, and fatal mischief will probably ensue.

Extraction of the Stone.—A forceps of sufficient length, of a size proportioned to that of the calculus, and previously warmed by immersion in tepid water, must be slid along the index-finger, which is kept in the wound, and by which the neck of the bladder should be drawn somewhat down so as to meet the instrument. In this way, also, the stone may often be fixed by the point of the finger, and its position thus accurately determined. The forceps having been introduced closed, the finger is withdrawn, when a gush of urine will usually take place through the wound, if that fluid have not already escaped at the time when the incision is made through the prostate. By this gush the calculus may sometimes be carried into the grasp of the instrument; most commonly, however, the stone requires to be felt for with the closed forceps. When its position has been ascertained, usually at the inferior fundus, the blades of the instrument are opened; and, by pushing one against the wall of the bladder, and giving it a slight shake, the calculus generally drops between them; though occasionally it is somewhat troublesome to seize, and this, indeed, often constitutes the most tedious and annoying part of the operation. Fergusson advised holding the forceps transversely, opening them as widely as possible, then giving a quarter turn so as to make the lower blade scoop along the floor of the bladder, when on closing the forceps the stone will usually be caught. The stone is then drawn downwards through the wound. If it be small, it may be extracted at once without any difficulty; if it be of moderate size, the finger should be introduced along the blades, in order to feel whether it is in a proper position for extraction. If its long axis lie across the wound, this must be changed; and it must then be withdrawn by a kind of to-and-fro movement in the direction of the axis of the pelvis (Fig. 885). Should the stone unfortunately be broken, or should there be several small calculi, the fragments or the small calculi may generally be best removed by means of the scoop (Fig. 886). In the event of fracture occurring, it will be necessary to wash out the bladder freely and repeatedly with tepid water, injected by means of a brass syringe through a tube introduced by the wound.

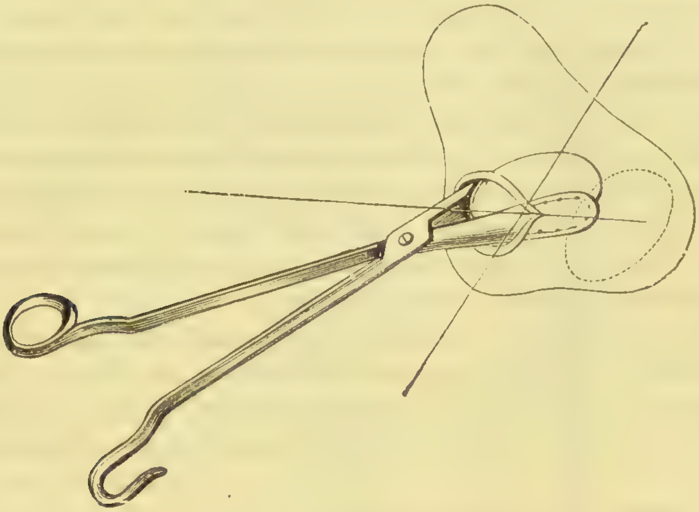


Fig. 885.—Direction of Forceps in Extraction of Stone.

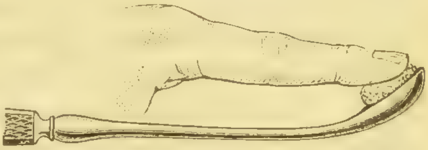


Fig. 886.—Position of Finger and Scoop in Extracting Stone.

If the perinæum be very deep, and the prostate enlarged, it may happen that the neck of the bladder is so far removed from the surface that the finger cannot reach its interior. In these circumstances, the Surgeon must be careful in passing the forceps, that the instrument do not slip to the side of the incision, the guide and support of the index-finger being lost. In two or three cases of this kind that have occurred to me, in which, owing to the anatomical reasons above stated, I could not reach the bladder with the tip of my forefinger, I have directed the assistant who held the staff not to withdraw it, but using it as a guide, have slipped the forceps along its groove and over its concavity, in this way making it enter the bladder with the greatest ease and certainty. This manœuvre I would strongly recommend in the cases alluded to.

It is of the first importance to extract the stone whole without breaking it, or even chipping fragments from it with the blades of the forceps. No effort consistent with the safety of the patient should be spared in obtaining this desirable result; not for the sake of any vain display of manual skill, but from a regard to the well-being of the patient. If the stone become broken by the attempt at extraction, what happens? The Surgeon is obliged to introduce repeatedly the forceps and the scoop in his attempts to clear the bladder; the mucous membrane of which, falling upon and enveloping the fragments, is liable to be pricked, bruised, and excoriated in the endeavour to seize them. The bladder requires to be frequently washed out with copious injections of tepid water, and the operation thus becomes greatly and dangerously prolonged. Even after much time and labour have been spent in these efforts, fragments are apt to be left behind which may occasion great present irritation, and, if retained, will form the nuclei of future calculi.

In children, and indeed in most cases in which the perinæum is not very deep, so that after the introduction of the finger the stone can be felt and hooked forwards, the scoop is a most convenient instrument for its extraction; and in these cases I have often employed it in preference to the forceps.

After the calculus has been removed, it must be examined for facets, and the finger must be passed into the bladder and its cavity explored while firm pressure is made above the pubes. In this way the whole interior of the bladder is easily explored except in those cases in which the perinæum is unusually deep. The interior of the bladder may be further explored by means of a *searcher;* and if other stones be found, they must be dealt with in the same way as the first.

If the urine has been foul before the operation, it is well to sponge the surface of the wound over with chloride of zinc (gr. 40 to ℥j.), and to insert a little iodoform.

The *gum-elastic tube* may then be introduced, and secured with tapes to a band round the patient's abdomen. This tube must be kept free from coagula by the introduction into it, from time to time, of the feather of a pen. The tube is of great service in preventing the wound from becoming blocked up by coagula, by which the free escape of the urine would be interfered with. By means of this tube a ready outlet is given to the urine, the chance of infiltration is lessened, and if there be hæmorrhage the wound may readily be plugged round it.

Lithotome for Lateral Lithotomy.—Surgeons have, at various times, expended much ingenuity on the construction of instruments calculated to facilitate the operation of lithotomy, and to enable the operator to make his incision with absolute precision. Most Surgeons prefer to rely on their own skill to accomplish this, and mechanical contrivances have very generally and perhaps somewhat unjustly been discarded. Of all the instruments of the kind referred to, that which is the invention of N. R. Smith, of Baltimore, is the most ingenious and practically useful.

The instrument consists of a staff with appliances, and a peculiarly shaped bent cutting gorget. It was first described and figured by Smith in 1831. It has undergone many modifications at the hands of its inventor, and is now given to the profession with all its improvements, as seen in Figs. 887 and 888.

The staff consists of three parts: 1. A rectangular tubular staff, with a wide slit making a quarter turn, so as to fit it for lateral lithotomy. 2. Attached to the staff by a hinge close under the handle, is an "arm-piece," or "conductor." This ends in a knife-blade, set at right angles to the shaft and deeply grooved at its under part. 3. An "indicator," which consists of a slender rod traversing the handle of the staff and terminating in a cup sliding in the tubular staff.

The mode of action of the instrument is as follows. The conductor being drawn back on its hinge, the rectangular staff is passed in the usual way into the bladder, the angle being brought just in front of the prostate and resting on the membranous part of the urethra. When the Surgeon has satisfied himself that the staff is in proper position, he draws down the conductor, and, pressing upon it, pushes its terminal knife through the tissues of the perinæum until it enters the slit in the staff. The groove in the "conductor" outside the perinæum is now continuous with that in the staff which is in the urethra. The "indicator" is now drawn up so that its cup lies immediately under the groove of the "conductor." The superficial incision having been made in the usual way, the urethra is opened on the groove in the "conductor"; the beak of the knife is then engaged in the cup of the "indicator," and as the knife advances the rod of the indicator descends, but ceases to move if the blade depart from the proper route by slipping out of the slit in the staff and stops when the end of the groove is reached. The knife, or gorget (Fig. 888), ends in a blunt beak, and the handle is set at an angle to the blade, so as to enable the Surgeon to watch more accurately its attitude and position.

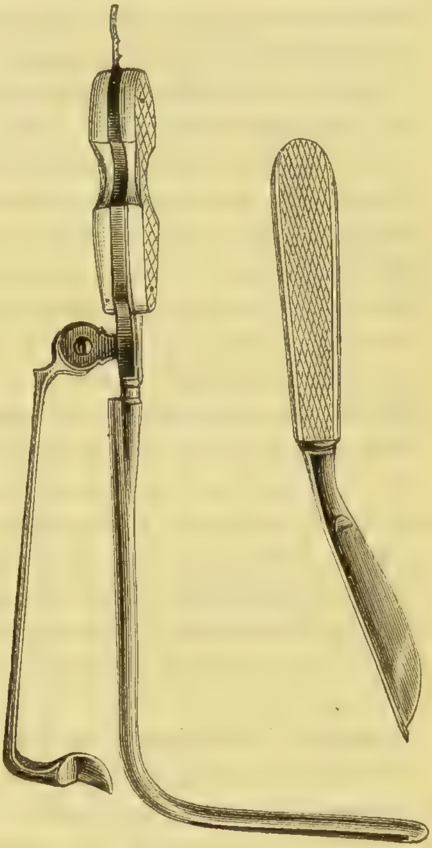


Fig. 887. — Smith's Lithotomy Staff and Conductor.
Fig. 888 (to right).—Smith's Gorget.

Professor Johnson, of Baltimore, has used this instrument many times, and speaks highly of its utility.

After-treatment of Lithotomy.—After the operation, the patient must be removed to a bed, which should be properly arranged by having a large square of Macintosh cloth put across it. On this a folded sheet should be laid, which must be rolled up on the further side, so that, as it becomes wetted by the escape of urine, it may be drawn across from under the patient. This must be changed frequently in order to keep him clean and dry. A full dose of tincture of opium in barley-water should then be given; a warm flannel laid across the abdomen; plenty of barley- or gum-water allowed for drink, and nothing but rice-milk or light pudding for diet during the first three or four days.

After this some broth may be allowed, and the quality of the food gradually improved. Occasionally, however, it may be necessary to depart from this routine system of dieting ; and I have, with great advantage, allowed wine, and even brandy, a day or two after the operation.

At the end of thirty-six or forty-eight hours the tube may be removed, the sides of the incision by that time having become glazed over, and little danger of infiltration existing. The patient, who up to this time has been lying on his back, should then be directed to change his posture, first to one side and then to the other. The buttocks and hips should be well oiled or smeared with vaseline, so as to prevent the irritating effects of the urinary drainage. The urine continues to flow entirely through the wound, and may be received in a large well carbolised bath sponge, which must be changed periodically. About the fourth or fifth day the urine frequently ceases suddenly to flow from the wound, escaping by the urethra. This is owing to the prostate becoming turgid from inflammatory swelling, and thus blocking up the aperture in it ; but as this swelling goes down, in the course of a day or two, the urine usually escapes by the wound again, and continues to do so in gradually decreasing quantities until the aperture is finally closed, which happens usually at about the end of fourteen or eighteen days ; though in patients who have suffered from phosphatic calculus it sometimes takes a longer period, owing to the broken state of the general health. Should the wound fall into a sloughy state, the patient must be put on a very generous diet, even a free allowance of stimulants : and the tincture of benzoin may be daily applied. When slow in healing, it may be stimulated with nitrate of silver applied to the bottom ; and, should a fistulous aperture be left, that may be touched with the electric cautery. After the operation, appropriate constitutional treatment should be continued for some time in order to prevent the recurrence of the disease.

Lateral Lithotomy in Boys under the age of puberty is one of the most successful of the great operations in Surgery. It is performed much in the same way as in the male adult ; there are, however, some points of modification or of difference in the operation when practised on young subjects. The following are worthy of note, and should be remembered by the Surgeon in proceeding to operate on children.

1. The urethra in boys will commonly be found larger than would perhaps at first be expected from their age, readily admitting a No. 8 or 9 staff.

2. The perinæum is usually proportionally more vascular in boys, in consequence of the straining produced by the irritation of the calculus.

3. There is often from the same cause a tendency to prolapsus of the rectum.

4. As the prostate is a rudimentary organ in the boy, the deep incision necessarily passes beyond its limits into the neck of the bladder.

5. In boys the tissues are more yielding, and more readily lacerable under the finger.

6. The most important point, however, is, that in the boy the bladder lies high, being rather in the abdomen than in the pelvis ; hence, it is of importance to raise the point of the knife somewhat more than in the adult in making the deep incision, and to be careful that it do not slip into the tissues between the rectum and the bladder, which may happen unless this precaution be taken.

I have known this to occur in several instances to Hospital Surgeons of skill and experience, the forceps being passed into this space under the supposition of its being in the bladder; and in every case the patient died unrelieved. This accident is the more likely to happen, because in boys the parts are very yielding, and readily admit of being pushed before the knife or finger; and the finger may thus pass between the neck of the bladder and the pubes, or into the loose areolar tissue between the rectum and the bladder. The urethra being opened, urine escapes; and the Surgeon introduces his finger into a distinct cavity, which he believes to be the interior of the bladder, but which is not so, but the recto-vesical space. The liability to the occurrence of this distressing and fatal accident is materially lessened by injecting the bladder fully with tepid water, by which it is steadied and brought lower down. But in young boys lithotomy is from this cause always an anxious operation. It falls to the lot of but few Surgeons of experience in lithotomy to pass through an active professional life without meeting with difficulty and anxiety in operating on boys; and when such an untoward accident occurs, those will be the most charitable in their judgment of others, who have themselves had the most experience in the operation and have had most frequently to encounter its intrinsic difficulties.

In order, then, to obviate the special dangers that have just been mentioned as likely to occur in the lateral lithotomy of boys, the following points should be attended to.

1. The bladder should be injected with two or three ounces of tepid water.

2. The knife should not be too narrow, as it has to make an opening of sufficient size to admit the forefinger of the operator in the child as in the adult. Its point, when it has entered the groove of the staff, should be kept very firmly pressed against its side, and carried somewhat upwards instead of straight forwards.

3. When the knife is laid aside and the Surgeon proceeds to pass his finger into the bladder, he will find the following manœuvre facilitate this step of the operation very greatly, and lessen materially the danger of pushing the neck of the bladder before him. Placing the nail of the left index in the groove of the staff, he should not carry it along the convexity of this instrument, but, sliding it over to the concave side, gently but steadily work his way along this into the bladder. In doing so, he passes the finger between the roof of the urethra, which is a fixed part of the canal, and the staff, instead of between this and the floor of the urethra, which is mobile and yielding. There is the additional advantage that, by pressing down the staff as the finger goes above it, the urethra and neck of the bladder are somewhat dilated.

C. Heath recommends the following plan, which will be found most efficient; as soon as the knife is withdrawn he inserts a strong director with a handle like that of a staff set at a convenient angle. This is passed along the groove of the staff like the conductor in median lithotomy. The staff is then withdrawn and the finger passed above the director, which is at the same time pressed downwards.

4. As soon as the finger enters the bladder and the staff is withdrawn, the calculus should be fixed with its point against the floor of the bladder, where it may then be seized easily by the forceps.

Difficulties during Lithotomy.—The difficulties before and during the operation are three-fold ; 1, in Finding the Stone ; 2, in Entering the Bladder ; and 3, in Seizing and Extracting the Calculus.

1. **Difficulty in Finding the Stone,** either by the staff or by the sound, may exist before commencing the operation ; and sometimes it is impossible to find the stone, although its presence may have been distinctly and incontestably ascertained a few days previously. In these circumstances, the Surgeon must on no account be tempted to proceed with the operation ; but, after a carefully conducted exploration has failed to elicit the actual presence of the stone, all further proceedings must be deferred to another opportunity, The stone may escape detection in three ways. 1. It may have been passed by the urethra, between the first examination and the time fixed for the operation. A small calculus, especially if elongated and spindle-shaped, may give a very distinct click against the sound, and yet be not too large to pass through the urethra. 2. The stone may have become encysted. 3. It may have become enveloped in folds of the mucous membrane of the collapsed bladder, and so may escape contact with the sound. All these events, except the presence of an encysted calculus, are more likely to happen in children than in the adult, and it is in them that, for want of attention to these precautions, the unfortunate accident of cutting into the bladder and finding no stone has most frequently occurred.

2. **Difficulty of Entering the Bladder.**—This is rarely experienced in adults. It may, however, arise in consequence of the Surgeon neglecting to keep the point of the knife well lodged in the groove of the staff, and thus letting it slip between the rectum and the bladder; the tissue of which, being broken up, leaves a kind of cavity that he mistakes for the interior of the bladder. If the perinæum be very deep and the prostate enlarged, he may also experience some difficulty in reaching the bladder ; but he can scarcely fail to do so if he push the knife well on the groove of the staff, and dilate the incision in the prostate with a blunt gorget, if his finger fail to reach the cavity beyond it.

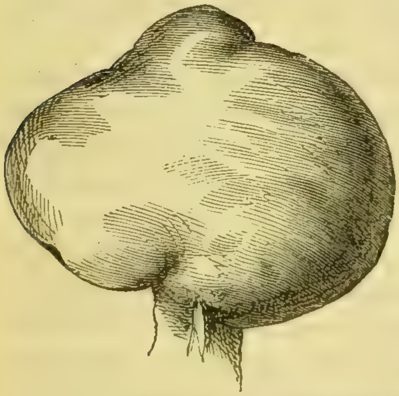


Fig. 889.—Tumour of Prostate, natural size, removed during Lithotomy from a man aged 64.

Perhaps the most serious obstacle to entering the bladder consists in the presence of large tumours in the prostate. The combination of a deep perinæum, an enlarged prostate, and a tumour, certainly constitutes a formidable series of obstacles. In these cases, the finger when slipped along the staff does not enter the bladder, but becomes involved in the smooth and irregular sinuosities that wind between the prostatic tumours (Fig. 889). In such cases it is well to practise the manœuvre that has already been described ; viz., of using the staff as a guide into the bladder, slipping the forceps along the side and concavity of this instrument before it is withdrawn.

In *boys*, great and sometimes insuperable difficulty has been experienced in reaching the bladder. This difficulty arises in consequence of the small size of the urethra, the mobility of the bladder, and the ready lacerability of the tissues. If, after the groove in the staff has been exposed, care be not taken to insinuate, as it were, the nail into the opening in the urethra thus made, the membranous portion may be torn across; and the neck of the bladder, receding before the finger, may easily be pushed away from the surface, so that the Surgeon may fail in reaching the cavity of the organ. When the road is once lost in this way, there is the very greatest difficulty in finding it again. The course that should be pursued is, I think, as follows. If the staff have not been withdrawn, the Surgeon must again place the knife in its groove, and carefully push it on towards the neck of the bladder, notching that structure and passing the finger cautiously along the groove, and hooking down the parts with his nail until he reach the inside of the bladder. Should the staff have been withdrawn, the Surgeon must endeavour to pass it again; if he succeed in this, he may act as just stated; but if he cannot succeed in introducing the staff fairly into the bladder, he must on *no account whatever* endeavour to open that viscus, or continue his attempts at the extraction of the calculus, but must at once abandon the operation until the parts have healed, when he can repeat it. The great danger in these cases arises from the Surgeon losing his presence of mind, and endeavouring to enter the bladder without a guide—a procedure which must be unsuccessful, and can end only in the destruction of the patient.

In adults, the difficulty is to get out the stone; in children to get into the bladder.

3. **Difficulty in Seizing and Extracting the Stone** is far more frequently met with than in reaching the bladder. This may be owing to a variety of causes. It is likely to happen in all those cases in which, either from the depth at which the bladder lies from the surface, or from the peculiar position of the calculus, the stone cannot be felt with the finger after the incisions have been made into the neck of the bladder.

Difficulty from the Position of the Stone.—The calculus may be lodged *in the lower fundus.* This is especially apt to happen if the patient be old and fat, and have a deep perinæum, perhaps with an enlarged prostate, behind which the stone may be lodged. Here the best plan is to use a much-curved pair of forceps, and to tilt the bladder up by introducing the finger into the rectum, so as to bring the stone within reach.

When the stone is situated *in the upper fundus* of the bladder above the pubes, it is altogether out of the axis of the incision, and in such a case can be extracted only with great difficulty. Aston Key recommends that in such cases the abdomen should be compressed, and the calculus thus pushed down into reach. This suggestion is a very useful one; and it was only by employing this manœuvre and using a very curved scoop, that I could remove a calculus lodged above the pubes, in the first patient whom I cut at the Hospital.

Difficulty in consequence of the Stone being Fixed to or Retained in the Bladder.—A small calculus may be *enveloped by the folds of the mucous membrane*, and in this way elude the grasp of the forceps. In these circumstances there is nothing for the Surgeon to do, but patiently to try to disentangle and remove the calculus by means of the finger and scoop, if it can be so reached; if not, by expanding the forceps in the bladder, to try to push aside the mucous membrane that surrounds the stone.

In consequence of **Spasm of the Bladder**, it is said to have occasionally happened that a calculus has been so firmly fixed as not to admit of the application of the forceps, the blades of which could not be introduced between the walls of the viscus without using an improper degree of force, and giving rise to the danger of rupturing the neck of the bladder. I am disposed to think that this "spasm of the bladder" is purely imaginary, and that the real difficulty has arisen from some other cause, as perhaps a contracted and rickety pelvis. But, whatever may be the real cause of a difficulty that has undoubtedly been encountered, I think it would be safer for the Surgeon to desist from the operation, and in the course of a few days or weeks endeavour to complete the extraction, and thus perform the operation "*à deux temps*" of Deschamps.

The stone may be so **fixed between hypertrophied fasciculi** in the interior of the bladder, as to be detached with considerable difficulty. In such cases, the scoop will be found to be the most useful instrument for its removal.

When the calculus is **encysted,** its extraction will probably be impracticable, or attended with most dangerous consequences. Hence, it is expedient not to operate in cases of encysted calculus that are known to be such. If, however, the Surgeon have been unfortunate enough to cut into a bladder containing an encysted calculus, he must be guided in the course he should adopt by the condition in which he finds the stone. If the aperture leading into the cyst be very small, as in Fig. 861, the better plan will be to proceed no further with the operation, as it will be clearly impossible to remove the stone. If, on the other hand, the aperture into the cyst be large, he might feel disposed to make an effort to extract the calculus. With this view he might adopt the plan pursued by Sir B. Brodie in such a case, and endeavour to enlarge the orifice of the cyst by means of a probe-pointed bistoury cautiously applied, and then finish the extraction by means of a scoop. Such a proceeding, however, is in the highest degree hazardous, on account of the readiness with which the section may extend into the peritoneal cavity; as well as difficult in execution, from the depth at which the parts are lying.

I believe that a calculus may occasionally become encysted, or rather encapsuled, in another way,—by being covered in by a kind of false membrane whilst lying on the floor of the bladder. This condition I found in a boy on whom I operated for stone some years ago. After removing a calculus of about the size of a pea, I felt, with the end of the finger, a hard irregular body, covered apparently by mucous membrane, lying at the inferior fundus of the bladder. On scraping through the membrane covering this with the point of my nail and a curved scoop, I exposed the calculus (Fig. 858), and removed it, with a cyst attached to it. On examining the structure of this cyst, which was of about the thickness of ordinary writing paper, of a reddish colour, and resembling a piece of mucous membrane, it was found to be a false membrane, composed of organized fibro-cellular tissue. The patient made a good recovery, with the exception of a slight attack of secondary hæmorrhage, which occurred on the eighth day after the operation.

Fibroid Tumours in the Prostate constitute sometimes rather a serious difficulty in lithotomy. They may do this in two ways: first, by elongating the prostatic part of the urethra to so great an extent as to carry the neck of the bladder far from the surface; and, secondly, by being in the way during extraction of the stone. A tumour of this kind, an inch or more in diameter, necessarily fills up to a very serious extent the space in the wound through which the stone has to pass; it jams up the orifice and prevents the free play of the forceps. These tumours, however, when caught between the blades or shanks of the forceps, soon shell out, and, rolling out of the wound, allow the easy exit of the calculus after them (Fig. 889).

Deformity of the Pelvis from Rickets may constitute a serious or even an insuperable obstacle to the extraction of a calculus. This condition may act in two ways. It may narrow the brim of the pelvis in its antero-posterior diameter, to so great an extent as to prevent the passage of the stone downwards after it has been seized by the forceps. This condition is more to be feared in children, in whom the bladder, being an abdominal organ and lying high, is altogether above the brim of the pelvis in these cases. Or there may be difficulty in the extraction of the stone through the inferior outlet, owing to the approximation of the rami on each side. The first cause of difficulty once occurred to me, in operating on a very rickety boy four years and a half old. Of the second I have had no experience. The rickety condition of the pelvis may be suspected in cases in which the lower limbs are much distorted. Its existence may be ascertained, by digital exploration of the rectum, and by external measurements. If it be found to exist to an extreme degree, the suprapubic operation must be performed.

In old men the outlet of the pelvis may be greatly narrowed as a consequence of senile osteomalakia. This is recognized by the approximation of the ischial tuberosities.

Difficulty depending upon the Shape and Size of the Stone.—If the stone be very round, it is usually more difficult to seize than when flat or elongated. Flat, disc-shaped calculi, however, occasionally fall into the fundus of the bladder behind the prostate, and then cannot be readily reached by the forceps, which passes over them. In these circumstances, they are best extracted by the curved scoop. Very flat broad calculi, and those that are round, egg-shaped, or branched, are the most difficult to remove, even though their size be not very great. As a general rule, however, it may be stated that, the larger the calculus, the more difficult is its extraction. There will always be considerable difficulty in extracting calculi weighing six or eight ounces and upwards; though cases are recorded by Cheselden, Klein, and others, in which calculi from twelve to fifteen ounces in weight have been extracted by the lateral operation. Any calculus above one inch and a half in its shorter diameter will be hard to extract through an incision of the ordinary length in the prostate, even though this be considerably dilated by the pressure of the fingers: and I think it may be safely said, that a calculus two inches and upwards in diameter can scarcely be removed by the ordinary lateral operation with any degree of force which it is safe to employ. The practice adopted in such a case, more than a century ago, by Gooch, of Norwich, is probably the best that can be pursued. It consists in drawing the stone well down with the forceps, and then letting an assistant carefully divide the tissues that resist. In this way, by a process of traction, twisting, and division, the stone may be brought out with safety. In the facility with which the calculus is extracted, however, much will depend upon the make of the forceps. As Liston most truly observes, "There can be no more fatal error than to attempt the extraction of a large stone with short and shabby forceps." In these cases the open-bladed forceps (Fig. 869) will be found useful, the absence of metal in the most convex part of the blade lessening materially the bulk of the instrument when grasping a stone.

In the event of the calculus being too large for extraction by the ordinary lateral operation, what course should the Surgeon pursue? Three are open to him: 1. Division of the Right Side of the Prostate from the interior of the wound; 2. Crushing the Calculus in the Bladder, and then removing it; 3. The performance of the Recto-vesical Operation; 4. Removal by the Supra-pubic Operation.

The **Incision of the Right Side of the Prostate** gives considerable additional space, and is sufficient for most ordinary purposes; very large calculi being fortunately seldom met with. This section may be made by introducing into the wound a probe-pointed scalpel (Fig. 868), guided by the index-finger, and very cautiously dividing the right side of the prostate downwards and outwards, in the same direction that the section of the left has been made. This must be cautiously done. The parts, being put well on the stretch as the stone is drawn forwards, are carefully notched, and thus yield to the traction. In two cases I have seen Liston do this. In one the patient recovered, in the other he died of diffuse inflammation of the areolar tissue of the pelvis. I have practised it once on a patient at the Hospital, who made an excellent recovery.

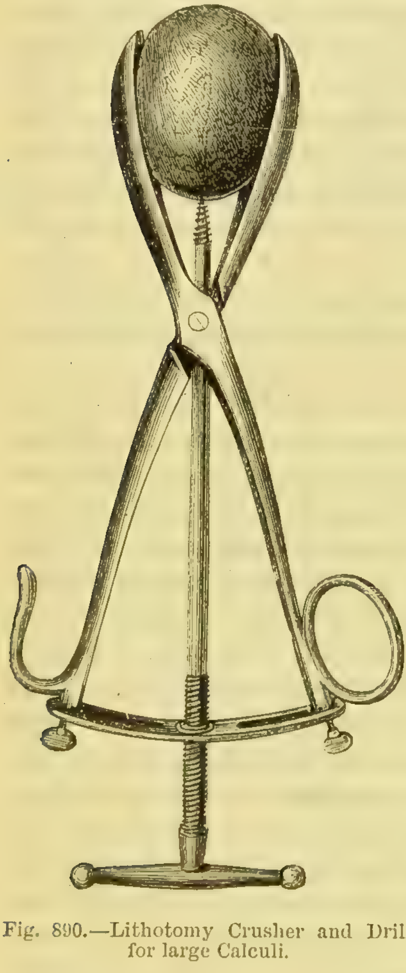


Fig. 890.—Lithotomy Crusher and Drill for large Calculi.

The second plan, that of **Crushing the Calculus in the Bladder** through the wound in the perinæum, would certainly be a hazardous procedure. The irritation that would necessarily be set up by the large lithotrite or crusher (Fig. 890) that has been invented for this purpose, by the presence of the fragments of stone, and by the necessary difficulty and delay of clearing them out of the viscus, would be a serious and possibly fatal complication of the operation. In the event of its being impossible to extract the calculus through the perinæum, I think it would be safer at once to perform the supra-pubic operation. The recto-vesical is not safer than the supra-pubic and is very apt to leave a fistula. The presence of the perinæal wound increases the difficulty of the supra-pubic, as the bladder cannot be injected, but does not increase the danger of the operation. Should, however, the unusually large size of the stone have been recognized before the commencement of the operation, it would be safer to practise at once the high rather than the lateral operation.

Difficulty from Fracture of the Calculus.—The difficulty of extraction is greatly increased if the stone be broken. Fracture of a calculus is of two kinds. In the one case the stone is simply broken into several fragments, or splinters, so to speak, are detached from it. This accident may happen to hard as well as to soft calculi, and is generally owing to the Surgeon employing too much pressure on the blades of the forceps, fearing that the stone may escape from between them ; or it may arise from the large size of the calculus requiring some force to be exercised in its extraction, when the Surgeon is very apt to compress the forceps as he draws the stone down. When this accident is found to have occurred, the Surgeon must remove with small forceps or the scoop the fragments that have been detached. He should then wash out the bladder by copious injections of tepid water, and very carefully examine its interior for any loose pieces. It is seldom that any worse consequence results from this occurrence, than delay in the completion of the operation.

The second mode of fracture consists in the crumbling down of the calculus as soon as it is seized by the forceps, into a soft mortary mass ; the stone is not broken into large pieces, but, having naturally little cohesion, disintegrates into a mass of softish fragments, none of which probably exceed a cherry-stone in size, and which indeed resemble a wet sabulous aggregation, rather than distinct pieces of calculus. This crumbling down can occur only in phosphatic calculi. It is in no way the fault of the Surgeon, but arises from want of cohesion in the calculus, so that the blades of the forceps bite, as it were, through it. It is an unpleasant accident to occur, as it becomes extremely difficult, if not impossible, to clear away the whole of the soft mortary detritus from the interior of the bladder, to the lining membrane of which it tenaciously adheres, small masses lying under the folds into which the contracted organ is thrown. As much as possible should be removed by the scoop, and the remainder washed away, as far as practicable, by copious injections ; with all care, however, some will be left, and may be discharged through the wound some days, or even two or three weeks, after the operation. When this happens, the bladder should be thoroughly washed out every day, or every second day, by warm water injections thrown in through a catheter passed down the urethra and allowed to regurgitate through the wound ; and this plan must be persevered in so long as any foreign body escapes. Should the wound have healed, the detritus must be treated as in lithotrity ; and the bladder must be washed out every second or third day by a large-eyed catheter, until all is removed.

ACCIDENTS DURING LITHOTOMY.—The principal accidents that may occur during the performance of the lateral operation of lithotomy are Hæmorrhage ; Cutting the Bulb ; Missing the Membranous Portion of the Urethra ; Wound of the Rectum ; or Wound of the Posterior Part of the Bladder.

Hæmorrhage during lithotomy may occur from three sources :—1. The Superficial Arteries of the Perinæum ; 2. The Deep Arteries of this region ; and, 3. The Prostatic and other Veins. When excessive, from whatever source it proceeds, it is always a very serious complication ; for, even if it do not prove fatal by the induction of syncope, &c., which I believe to be very rarely the case, it is apt to lead to a fatal termination indirectly at a later period, by predisposing to the occurrence of infective processes either local or general. I believe that patients who lose a large quantity of blood at the operation seldom recover.

1. Hæmorrhage from the *Division of the Superficial or the Transverse Artery of the Perinæum* is seldom very dangerous, though occasionally, if these vessels be larger than usual, they may furnish a serious quantity of blood ; in such circumstances their ligature would be required, and might be practised either before or after the extraction of the calculus. It is better, if possible, to wait until the completion of the operation, lest the ligature be pulled off during the extraction of the stone.

2. The *Division of the Deep Arteries* of the perinæum, that of the bulb and the internal pudic, would be attended by far more serious, perhaps even by fatal consequences; as, from the depth at which the vessels are seated, it would be almost impossible to apply a ligature to them, unless the patient were very thin, and the perinæum proportionately shallow. The facility of ligaturing any of these arteries, especially that of the bulb, when wounded, is greatly increased by enlarging the incision upwards. In the event of a ligature not being applicable, the Surgeon would have to trust to plugging the wound round the tube, as described further on, or to the pressure of an assistant's fingers continued for a considerable time, or to the application of forcipressure forceps. The pressure of the fingers of relays of assistants, kept up for a considerable length of time, although it seems to have been an efficient mode of treatment, is painful to the patient, and is difficult to carry out. The pressure must be kept up for many hours; thus South relates a case in which it was maintained for fourteen hours; and Brodie one in which, after twenty-four hours, it succeeded. The assistants should not be changed more frequently than necessary, each keeping up pressure for two or three hours, and removing his fingers as cautiously as possible. It is, doubtless, very rare for these arteries to be wounded when they follow their usual course; though such accidents have happened in the hands of some of the most skilful lithotomists, such as Home, Bell, Roux, and Desault. It was the opinion of Aston Key that the artery of the bulb was generally cut during lithotomy; but in this he was mistaken, so far as its trunk is concerned, though doubtless in many cases the bulb itself may be wounded, and the mesh of twigs, in which the vessel terminates, divided; this, however, would not yield an alarming hæmorrhage. The trunk of the artery of the bulb would, however, be endangered by opening the urethra too high up, and lateralizing the knife too early, and if wounded it bleeds very freely.

It may happen that on pulling the wound widely open the bleeding point may be seen, but at such a depth that it is impossible to apply a ligature. It may then be seized in torsion or forcipressure forceps and immediately twisted, or if this does not succeed the forceps may be left hanging on the vessel for a few hours. For this purpose the forcipressure forceps are the best, as they more efficiently crush and obliterate the vessel.

The internal pudic artery, bound down by a strong fascia, and under cover of the ramus of the ischium, runs but little risk unless the knife be lateralized too much, and the incision be carried too far outwards. In children in whom the ramus of the ischium is to a great extent cartilaginous, this accident could more easily happen. It is in some of the anomalous distributions of these vessels that the greatest danger would be occasioned. The artery of the bulb, the inferior hæmorrhoidal, the dorsal artery of the penis, or the internal pudic, may take such an anomalous course that its division is inevitable; and, as the Surgeon has no possible means of knowing beforehand whether the distribution of the arteries is regular or not, and as his incisions are all planned on the supposition that they are, he is not to blame in the event of a vessel being accidentally divided, when it takes an abnormal direction, with which it is impossible to be acquainted until after the accident has occurred.

If the incision be commenced too high up, and especially if the upper part of the first incision be made by pushing the knife in too deeply, the corpus spongiosum and its vessels may be wounded.

It may be stated as a general rule, that serious hæmorrhage is usually best avoided by making the incisions low; and indeed, I believe that the great secret of success in the lateral operation of lithotomy consists in making all the deep incisions as low as practicable; the knife entering the groove of the staff from below upwards, rather from above downwards.

3. *Venous Hæmorrhage* may occur from two sources—the superficial or the prostatic veins. It is very seldom that any trouble arises from superficial veins; but in one case I have seen very considerable loss of blood occur from a large vein, running transversely near the upper angle of the wound, lying almost immediately under the skin, which had been incompletely divided. From the prostatic plexus hæmorrhage is most likely to occur in old people, in whom the veins in this situation are often enlarged—almost varicose.

Whether the blood come from a superficial or from a deep source, it is very apt to find its way back into the bladder, to mix with the urine, and thus to escape through the tube rather than from the wound itself; or the blood may probably coagulate in the interior of the bladder, distending that organ and producing a feeling of dysuria. Should it proceed from a superficial source, it may be necessary, as was done in the case just alluded to, to pass a ligature under the vessel, and thus arrest it. If it occur from the prostatic veins, the better plan will be to plug the wound. This is done by passing long strips of lint, either dry or soaked in a solution of perchloride of iron or of alum, along the side of the tube, which must be left in the wound and kept pervious: or the lithotomy tube may have a "petticoat" of thick muslin tied around it, into which the slips of lint are stuffed. The advantage of this arrangement is, that the whole apparatus may very easily be removed together at the end of forty-eight hours.

A far more efficient means of applying pressure is the "Air Tampon," invented by Buckston Browne. It consists of an ordinary gum-elastic lithotomy-tube, surrounded by an india-rubber bag, which can be distended with air from a syringe by means of a tube fitted with a stop-cock. This is inserted into the wound, so that the india-rubber bag fills its whole length. On distending the bag, firm uniform pressure of any desired force can be applied. After from twelve to twenty-four hours, a little air can be let out so as to reduce the pressure, and this is repeated at intervals till the tube can be removed.

Hæmorrhage from any of the above-named sources, but more especially from the deep arteries and veins, may take place into the bladder. When this occurs, the urine that escapes will be seen to be deeply mixed with blood, and coagula will form in the interior of the viscus, which becomes distended and rises above the pubes, with dulness on percussion in the hypogastric region. The patient will become pale, faint, and cold. In such circumstances, the coagula must be washed out of the bladder with cold water, the source of hæmorrhage ascertained by an examination of the wound, the further flow of blood arrested by plugging or ligature, restoratives administered, the pelvis placed high, and the patient kept cool. If there is any difficulty in washing the clots out of the bladder they may easily be sucked out by applying the aspirator to the tube.

Wound of the Bulb is not of very uncommon occurrence in lithotomy; and, I believe, is of no consequence beyond furnishing a small additional quantity of blood. Indeed, the bulb is so situated, in many cases overlapping the membranous portion of the urethra, that this can scarcely be opened without wounding it.

Missing the Urethra altogether, and opening up the bladder through or even altogether beyond the prostate, is an accident that may happen if the Surgeon miscalculate the depth of the perinæum, and keeping the incisions too low, thrust the knife too deeply. It is, I believe, an inevitably fatal accident, as in it the base of the bladder and the recto-vesical fascia are opened, and the patient is thus exposed to the occurrence of diffuse inflammation of, and infiltration into, the pelvic areolar tissue. I was present many years ago at the *post-mortem* examination of a fatal case of lithotomy, in which perhaps the most skilful operator of that day had opened the bladder beyond the prostate, leaving the urethra untouched ; the patient died from the cause just stated.

Wound of the Rectum occurs more frequently than is generally supposed. It may happen either in consequence of the staff being too much depressed, of the edge of the knife being turned too directly downwards, or of the rectum being distended and overlapping the sides of the prostate. I have also known the lower part of the rectum perforated by the Surgeon's finger, whilst depressing the gut so as to keep it out of the way of the knife. The *Treatment* of this accident will vary according to the size and situation of the aperture. If it be of but moderate extent and low down, just above the anus, it will probably close as the wound granulates and the urine resumes its passage through the urethra. If the incision be more extensive and higher up, the patient will incur the risk of the miserable infirmity of recto-vesical fistula. In such circumstances, the proper treatment is to divide the sphincter ani from the opening downwards, and thus to lay the gut and wound into one cavity which will probably fill by granulation, and thus close the urinary passages.

Wound of the Posterior Part of the Bladder is very rare ; yet it has happened in consequence of the knife being thrust too deeply along the groove of the staff, more particularly in operations on children, and would be specially apt to happen in such cases if the bladder did not contain sufficient urine at the time. This is an additional reason for injecting the bladder before operating.

In *children,* the lateral operation of lithotomy presents certain special difficulties which have already been adverted to. These are : 1, the Surgeon missing the bladder and opening up the recto-vesical space (p. 1014) ; 2, not opening the urethra and neck of the bladder sufficiently with the knife, but pushing these parts before the finger, and so tearing across the urethra, and thus necessarily being unable to complete the operation (p. 1016) ; and 3, running the knife too far along the groove of the staff into the bladder, and thus wounding the posterior part of that organ.

Sources of Danger and Causes of Death after Lateral Lithotomy.—Lateral lithotomy, even in healthy subjects, is always a dangerous operation ; and, though the rate of mortality doubtless depends greatly upon the dexterity and skill of the operator, more is, I believe, due to the constitution and age of the patient, and especially to the state of his kidneys. Sir B. Brodie most justly says, "Success in lithotomy most undoubtedly depends in a great degree on the manual skill of the Surgeon, and on the mode in which the operation is performed ; but it depends still more on the condition of the patient with respect to his general health, especially on the existence or non-existence of organic disease." That the mere cutting into the bladder is not a very dangerous proceeding, provided that viscus and the kidneys be healthy, is evident from the fact that, in those cases in which Surgeons have had to extract bullets, bits of catheter &c., from this organ, bad consequences have rarely occurred, though the operations have often been tedious. In lithotomy the case is different ; for here the bladder is not only usually in a state of chronic irritation, but the kidneys are frequently diseased, and these conditions influence the result of the operation more materially than any other circumstances. Hence an operator may have a run of unsuccessful cases ; or, by a fortunate concurrence of favourable cases, more particularly in children, it has occasionally happened that a Surgeon has cut 20 or 30 patients in succession without losing a single one ; but several deaths then occurring, though the operation was performed in the same way and with the same care as before, his average has fallen to about the usual level. Green, at St. Thomas's, cut 40 patients in succession, and lost only one. Lynn cut 25 patients for stone without losing one, and he said that he thought he had at last discovered the secret of performing lithotomy with success ; but, he added, the Almighty punished him for his presumption, for he lost the next 4 cases that he cut. Bransby Cooper, of Guy's, cut 30 patients in succession without a death, but then lost several, thus reducing the rate of mortality to the usual standard. Liston, during a period of six years, in which he operated 24 times, lost no patient from lithotomy at University College Hospital ; but out of the whole 37 cases which he cut during the period of his connection with that institution, there were 5 deaths ; reducing the average to 1 in 7·2. This success was, however, very great when it is taken into consideration that most of these cases occurred in adults, and that many of them were of a very serious character. I find on reference to the Hospital records, that only 7 of the patients were under 10 years of age, whilst 14 were above 50 ; of these two were 80 years of age, of whom 1 died and the other recovered. I believe that Liston lost only one patient under 60 years of age, and that was a lad of 18, in whom he found it necessary to divide the right side of the prostate as well as the left, and who died of infiltration of urine. Thirty-eight patients successively operated on at the Norwich Hospital recovered, but the average rate of mortality in that institution, calculated from 871 cases, has been 1 in 7·50.

The accompanying Table gives much valuable information on the rate of mortality after lateral lithotomy at different ages. It may be taken as a fair example of successful English practice in this operation.

TABLE OF PATIENTS ON WHOM LATERAL LITHOTOMY WAS PERFORMED AT THE NORFOLK AND NORWICH HOSPITAL FROM JANUARY, 1772, TO DECEMBER, 1869. BY CHARLES WILLIAMS, F.R.C.S., ASSISTANT SURGEON TO THE HOSPITAL.

Age of Patients Operated upon.	No. of Cases.	Per centage of the whole number.	Recoveries.	Per centage of Recoveries.	Deaths.	Per centage fatal.	Proportion fatal.	No. of Cases.	Per centage of the whole number.	Recoveries.	Per centage of Recoveries.	Deaths.	Per centage fatal.	Proportion fatal.
1 to 5	185	21·23	169	91·36	16	8·64	1 in 11·56	335	38·46	314	93·74	21	6·26	1 in 15·95
5 ,, 10	150	17·22	145	96·6	5	3·4	1 ,, 30							
10 ,, 15	73	8·38	66	90·41	7	9·59	1 ,, 10·42	113	12·97	100	88·50	13	11·50	1 ,, 8·69
15 ,, 20	40	4·59	34	85	6	15	1 ,, 6·6							
20 ,, 30	51	5·85	46	90·20	5	9·80	1 ,, 10·2	103	11·82	93	90·30	10	9·70	1 ,, 10·3
30 ,, 40	52	5·97	47	90·39	5	9·61	1 ,, 10·4							
40 ,, 50	58	6·65	44	75·87	14	24·13	1 ,, 4·14	178	20·44	142	79·77	36	30·23	1 ,, 4·94
50 ,, 60	120	13·89	98	81·7	22	18·3	1 ,, 5·45							
60 ,, 70	119	13·66	90	75·43	29	24·57	1 ,, 4·06	142	16·30	106	74·55	36	25·45	1 ,, 3·94
70 ,, 80	23	2·64	16	70·84	7	29·16	1 ,, 3·42							
Total	871		755	86·68	116	13·32	1 in 7·50	871		755	86·68	116	13·32	1 in 7·50

Cheselden only lost 1 in every $10\frac{3}{4}$; and, according to South, at St. Thomas's the mortality has not amounted to more than 1 in $9\frac{3}{4}$; but a good many of these patients were probably children. Sir B. Brodie states, that of the 59 cases operated on in all the London Hospitals in the year 1854, 10 died; making the mortality as nearly as possible 1 in 6. But the more recent and extended statistics collected by Thompson, show that the average mortality in the London Hospitals is 1 in $7\frac{1}{4}$. According to Coulson the average mortality in England, deduced from 1,743 cases of the lateral operation, is 1 in 6·93 cases; whilst in France it is 1 in 5·7; and for Europe generally 1 in 5·14. The more recent statistics of Sir H. Thompson show a more favourable result for lateral lithotomy in England. He finds that out of 1,827 recorded cases there were 229 deaths, or nearly as possible 1 in 8. Klein states that, of 4,486 cases of lateral lithotomy, in Moscow, there were 552 deaths; the mortality thus being nearly the same as in England.

The percentage of deaths after lithotomy in the adult will doubtless be found gradually to increase with the increasing use of lithotrity. This must not be referred to any defect in the method, or to want of skill in the performance of lithotomy, but to the fact that, instead of, as heretofore, being the general method of removing calculus, it has now become the exceptional one. Almost all cases of small and moderate-sized calculi in men with otherwise healthy urinary organs are now subjected to lithotrity, whilst those cases in which the stone is too large, or the kidneys, bladder, prostate, or urethra too diseased, to admit of this mode of operating, are reserved for lithotomy; and as the mortality after this operation increases in the exact proportion to the size of the stone and the disease in the urinary organs, we must expect that, when its performance is confined to persons with large calculi, irritable bladders, enlarged prostates, diseased kidneys, or strictured urethræ, a higher percentage of deaths will follow it than was the case when all favourable cases, and not the unfavourable ones only, were subjected to it.

Age exercises a more marked influence on the result of lithotomy than any other condition. Lithotomy may be looked upon as one of the most successful operations in surgery at early periods of life, a hazardous one in middle age, and an extremely dangerous one in advanced age. At the Norwich Hospital, lithotomy has been found to be four times as fatal in men as in boys. Coulson finds, on analysing 2,972 cases of lithotomy, that the mortality at each successive decennial period is as follows: Below 10 years it is 1 in 13, and thence gradually augments from 10 to 80 years to 1 in 9, 1 in 6, 1 in 5, 1 in 4, 1 in 3·65, 1 in 3·23, and 1 in 2·71.

The reason of the small mortality after lithotomy in boys, as compared with adults, is most probably that the urinary organs, more especially the kidneys, are healthier than in the adult. Hence, when boys die after lithotomy, they do not usually perish from the same causes that prove fatal in the adult, viz., kidney-disease and diffuse pelvic inflammation and infiltration; but the fatal result is generally the consequence of some accident having occurred or violence having been inflicted during the operation, such as by mistaking the recto-vesical space for the interior of the bladder, the tearing across of the urethra and non-extraction of the stone, wounding of the recto-vesical fold of peritoneum, or perforation of the back of the bladder by the point of the scalpel. It is by these accidents usually that death happens in boys that are cut for stone, and not from unavoidable circumstances that may follow the most skilfully performed operation.

The **Shock of the Operation** occasionally proves fatal, though probably much less frequently since the introduction of chloroform than was formerly the case. Yet, even now, patients occasionally die from this cause, induced either by a very much prolonged operation, or by the system being weakened, in consequence of disease of the kidneys, perhaps of a latent character.

The **State of the Kidneys** influences the result of lithotomy in the adult more directly than any other condition. If these organs be sound, the patient will usually recover; hence in children, in whom the complication of renal disease rarely exists, lithotomy is very successful, even though the operation is proportionately far more severe in them than in adults. If, on the other hand, the kidneys be extensively diseased, the patient will commonly die, even though he have been operated upon with the utmost skill. The condition of the kidneys that is especially fatal has been described in Chapter LXVI.

A **Prolonged Operation,** even under anæsthetics, is dangerous; and, although it is certainly not well to operate against time, yet it is undoubtedly advantageous to finish the operation with as little delay as is consistent with the safety of the patient, even though he be anæsthetized.

Hæmorrhage does not so often prove fatal, either shortly after the operation, or at a later period, as might be expected from the great vascularity of the parts incised. Secondary hæmorrhage, of a dangerous or even fatal character, may, however, come on six, eight, or ten days after the operation. I have known it as late as the fourteenth day. It must be borne in mind that, when hæmorrhage takes place after the operation, the blood may find its way into the bladder rather than escape externally, distending the viscus with coagula, but not giving any external evidence of the mischief that has occurred. Secondary hæmorrhage will usually cease on plugging the wound with sponge or lint soaked in alum solutions. Should it prove serious, however, the actual cautery may be employed. In a case that occurred to me, the bleeding on the ninth day was stopped by wiping out the wound with the actual cautery, a practice which, I have been informed by A. Dalrymple, was occasionally practised by that excellent lithotomist, his father.

Cystitis is, in my experience, a rare sequence of lithotomy. I have, however, seen it occur, attended by the secretion of large quantities of viscid, ropy mucus from the bladder, coming away two or three days after the operation, with tenderness in the suprapubic region. It may exist before the operation, or may be produced by long-continued or rough manipulations with the forceps in searching for the stone, or by the irritation of the tube. It is more commonly caused by accumulation of putrid urine in a pouch behind the prostate. The symptoms are apt to simulate those of pelvic peritonitis. The *Treatment* consists of fomentations above the pubes, abundant diluents, and washing out the bladder through the wound with Condy's fluid diluted with tepid water.

Diffuse Inflammation of the Areolar Tissue of the Pelvis, especially of the layers around the neck of the bladder, between it and the rectum, which extend thence under the peritoneum, is the most frequent cause of death after lithotomy. This inflammation, which is always diffuse, followed by rapid sloughing of the textures that it invades, may arise from two causes: 1. From the urine being *infiltrated into the areolar tissue*, in consequence of the incision extending beyond the limits of the prostate, into the loose layers of tissue that lie behind the recto-vesical fascia and around the bladder; 2. In consequence of the *bruising and laceration* to which the neck of the bladder, the prostate, and the textures between it and the rectum, are subjected, in prolonged attempts to extract a large calculus through too small an incision.

1. The danger of *Cutting beyond the Lateral Ligament of the Bladder* in the adult has already been adverted to. In the extraction of calculi of ordinary size, there can be no necessity to extend the internal incision; but when the calculus is of considerable magnitude, the Surgeon, wishing to get as much space as possible, may inadvertently carry his knife beyond the prostate; or, if he make a cut into the right side of this gland, he may perhaps prolong it a little too far, and thus open the loose areolar tissue which lies beyond it, and which is continuous with the subperitoneal areolar tissue. By dilating the incision in the prostate downwards and outwards, either with the finger or with a blunt gorget, injury to this tissue is prevented.

If the incision extend beyond the prostate, the urine, as it escapes through the wound, soaks into the meshes of the loose areolar tissue over which it flows, and thus gives rise to infiltration, followed by rapidly extending inflammation and sloughing, which speedily involve the whole of the neighbouring textures. This mischief generally occurs within the first forty-eight hours; indeed, I have never seen it come on after the third day. It is indicated by the patient being seized with rigors, followed by dry heat of skin, a quick pulse, which, after a time, may become intermittent, and a dry and brown tongue. At the same time he will complain of some tenderness about the lower part of the abdomen, and in the groins; the belly becomes tympanitic, the body covered with a profuse sweat; hiccup comes on, the pulse becomes fluttering, and death usually occurs about the fourth or fifth day after the operation. In some cases, there are more decided signs of peritoneal inflammation; but, as Brodie very truly remarks, this is not the primary disease, but is only induced secondarily by the inflammation and sloughing of the areolar tissue of the pelvis spreading to the contiguous serous membrane.

The *Treatment* of such cases must be conducted on the ordinary principles that guide us in the management of diffuse inflammations. It is only by administering ammonia, with such a quantity of wine or brandy as the state of the system may indicate, together with such nourishment as the patient can take, that life can be preserved. The disease is a depressing one, and requires a stimulating plan of treatment. Brodie has recommended that in these cases a free incision should be made through the sloughy tissues about the wound into the rectum, in accordance with the general principles that guide us in the management of similar affections elsewhere. In one case of that kind that occurred under his care, he saved the patient by passing a curved probe-pointed bistoury into the wound to its furthest extremity, to the left side of the neck of the bladder; he then pushed it through the tunics of the rectum, and, drawing it downwards, divided the lower part of the gut together with the sphincter; thus laying the wound and the rectum into one. The relief was immediate, and the patient recovered. This plan of treatment certainly seems rational, and worthy of trial in similar cases.

2. Diffuse inflammation of the areolar tissue around the neck of the bladder and prostate arising from *Bruising and Over-distension* of the parts during the extraction of a large calculus is, I believe, a more frequent occurrence than

infiltration of urine, and fully as fatal. This sequence of lithotomy is especially apt to occur in those cases in which, in consequence of diseased kidneys, or the existence of other organic mischief, the patient is more than usually liable to the supervention of diffuse inflammation.

In the extraction of large calculi, considerable traction is required, and force must be exerted ; hence undue bruising and laceration are very apt to be inflicted upon the parts that constitute the line of incision. It is in this way that the danger of lithotomy increases almost in exact proportion to the size of the calculus : for here the Surgeon is often placed between the horns of a dilemma. He must either cut beyond the limits of the prostate, and thus incur the risk of inducing urinary infiltration into, and diffuse inflammation of the pelvic fasciæ; or else, by limiting his incision to the gland, and thus having an aperture of insufficient size, he may inflict severe injury by the bruising and laceration of parts during forcible and possibly prolonged efforts at extraction. It must, however, be borne in mind that, the larger the stone the more probability is there of the existence of old-standing disease of the bladder or kidneys, and of an unfavourable result from this cause. Crosse has drawn up a table that shows very strikingly the influence of the weight or, in other words, of the size of a calculus on the results of lithotomy. He found that when the stone was one ounce and under in weight, the deaths were in the proportion of 1 in 11·25 cases : when it was from 1 to 2 ounces in weight, there was 1 death in 6·61 cases : when from 2 to 3 ounces, 1 death in 2·18 cases : when from 3 to 4 ounces, 1 death in 1·57 cases : when from 4 to 5 ounces, 1 death in 1·66 cases. This table, which has been constructed on the results of 703 cases, illustrates very clearly these facts, that the operation for the removal of a large calculus is far more dangerous than that for the extraction of a small one, and that the danger increases in the direct ratio of the size of the stone.

The symptoms of diffuse inflammation of the areolar tissue arising from this cause very closely resemble those from infiltration of urine, and the treatment must be conducted on precisely similar principles.

Peritonitis may occur after lithotomy, as a consequence of the extension of inflammation from the bladder or the pelvic areolar tissue to the serous membrane, from wound of the posterior part of the bladder, or from extension of inflammation from a sacculus of the bladder to its immediate investment of peritoneum. To one or other of these conditions, more especially inflammation of the pelvic fasciæ, it will always be found to be secondary.

Sloughing.—In feeble and cachectic persons, especially in those who are the subjects of phosphatic calculi, the wound will often assume a sloughy condition, and heal slowly, and its surface may become coated with phosphates. In such cases a liberal allowance of stimulants will be required, together with the local application of compound tincture of benzoin ; and, in order to facilitate healing at a more remote period, a solution of nitrate of silver may be applied to the wound. The phosphates may be removed by injection of the dilute nitric acid lotion.

Pyæmia and Septicæmia are not uncommon causes of death after lithotomy. Acute septicæmia is usually the immediate cause of death in diffuse pelvic cellulitis, the patient perishing from general blood-poisoning rather than from the local condition. Pyæmia, when it occurs, usually sets in after the first week. The secondary abscesses are not uncommonly confined to the joints and subcutaneous areolar tissue, and the disease may assume a chronic form. The treatment presents nothing special.

OTHER METHODS OF PERFORMING LITHOTOMY.—Having finished the consideration of the lateral operation, we shall now proceed to that of other methods for extracting the stone by cutting. These are the *Median*, the *Bilateral*, the *Medio-lateral*, the *Recto-vesical*, and the *Suprapubic* operations; each of which has its advocates, to the exclusion of the others, and each of which undoubtedly possesses certain special advantages. In addition to these, there are various modifications of these operations which the ingenuity of Surgeons has devised, but which have usually little to recommend them in the opinions of any except their originators.

Median Lithotomy.—The median operation of lithotomy is that procedure by which a stone is extracted through an incision in the raphe of the perinæum extending into the urethra behind the bulb.

The **History of the Median Operation** affords an illustration of the mutability of professional practice, and makes it appear as if there were a cycle of opinion in surgery, as in fashion, politics, and philosophy. The median operation was introduced three or four hundred years ago, and continued to be practised up to the middle of the last century, when its tediousness, its painful character, and the excessive mortality following it, caused it to fall into disuse as soon as the safer and simpler method of Cheselden was introduced. However, it has been revived under a somewhat modified form; and it is this modern median operation, and its supposed advantages over the lateral, that we must here consider.

The old median operation—called also the "Marian," from Sanctus Marianus, who wrote on it, though it did not originate with him, and the "operation of the apparatus major," from the number of instruments used in it—was performed in the following manner, according to John Bell. A grooved staff was introduced into the bladder, and the patient tied up in the usual way; the lithotomist then, kneeling or sitting before him, made an incision in the perinæum, not exactly in the raphe, which was thought to be dangerous, but very slightly to the left side, and terminating just above the anus. The incision was then carried on to the membranous part of the urethra, which was opened on the groove of the staff; and, the knife being kept firmly pressed against the staff, a long probe was introduced into the bladder by its side. The knife and the staff were now withdrawn, nothing but the probe being left in the bladder, to serve as a guide. Along this probe, two iron rods, called "conductors," were now passed, and with these the operator dilated the prostate and neck of the bladder, by separating the handles; at least, it was said that he dilated them, but, as John Bell pithily observes, "he dilated, or, in plain language, tore open the prostate gland." These conductors being held aside, "dilators" were introduced so as to enlarge the opening, the forceps was then pushed into the bladder, and the stone extracted.

The principles of this operation were—a limited incision in the membranous part of the urethra above the anus; dilatation, and not incision of the prostate and neck of the bladder; or, to use the words of Le Cat, "small incision: much dilatation."

Its results were, however, so unsuccessful, that it fell into entire disuse here, and almost so on the Continent, merely appearing from time to time under various modifications at one or other of the Continental schools, and this condition of things prevailed until a new form of the median operation was devised by Allarton.

Operation.—This operation is performed as follows. A staff, grooved along its convexity, having been inserted into the bladder, the patient is tied up in the usual manner ; the Surgeon then, sitting in front, introduces his left index finger into the rectum, and feels for the apex of the prostate, against which he keeps it lodged, in order to judge of the distance of the prostate from the surface, to act as a guide to the knife, and prevent the rectum from being wounded. A straight-backed bistoury is now entered half an inch above the anal aperture, and pushed straight forwards, to a depth of about an inch and a half in the mesial line, so as to enter, if possible, the groove of the staff at the apex of the prostate. A small incision forwards is then made in the groove of the staff, and, as the knife is withdrawn, the incision in the skin is also extended forwards ; the knife is then laid aside, and a long ball-pointed probe is introduced into the bladder along the groove of the staff, which is then withdrawn. The probe is now the only guide to the bladder ; and up to this point, therefore, there is but little, if any, difference between the modern median and the old Marian operations, except that the incision is exactly in, instead of a little to one side of, the middle line. The forefinger is now introduced along the probe, and by working it forwards the prostate is dilated, and the finger enters the bladder, when, the probe being removed, the forceps is introduced, and the stone extracted. Thus it will be seen that the only real point of difference between this and the old Marian operation, is that in the former the finger is used as the dilator, whilst in the latter the prostate and neck of the bladder were forcibly expanded or torn open by instruments ; a difference, however, of no slight moment.

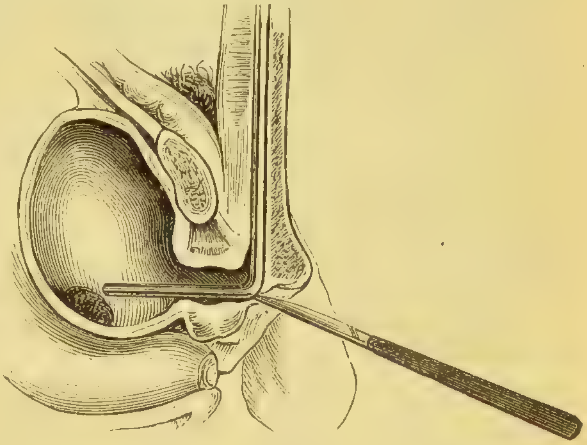


Fig. 891.—Median Operation with Rectangular Staff.

I have found it advantageous to modify this operation in one or two points. The first, which I think of some utility, is to use, instead of the ordinary curved staff, a rectangular one grooved from about one inch above the elbow nearly to the point, resembling the staff introduced by Buchanan of Glasgow (Fig. 891). Its use and advantages are that, when in the bladder, the angle rests against the apex of the prostate, and can be felt in the perinæum, and the Surgeon can judge of the exact point where to enter the knife (directing it so as to enter the groove just below the angle), which he cannot do with the curved staff ; the incision upwards also is limited, and there is, besides, less danger of wounding the rectum, the urethra being drawn upwards away from it, and not pushed down against it, as with the ordinary staff. The knife should be straight-backed, having the blade not more than two inches long ; so that the Surgeon can tell to what depth he has entered it. I have found it advantageous in practice to carry a beaked director, shaped like a large hernia-director, along the groove, after the incision has been made in the urethra, so as to open up the canal and thus to clear the passage for the finger. And having opened the urethra, I think it better to dilate the prostate before withdrawing the staff; by pushing the finger slowly, with a rotatory movement, along its side, the bladder is entered with more ease and certainty; whereas, if only the probe be used, it may not be stiff enough, and the Surgeon is apt to push the bladder before him. It has been proposed to employ mechanical means of dilatation, instead of the finger, to open up the prostate and neck of the bladder; and I had some dilators for this purpose constructed by Coxeter on the principle of the two-bladed dilator of the female urethra. I tried them on the dead subject; but I have not ventured to use them on the living, lest, by the employment of screw-power, the same deep lacerations of the neck of the bladder should result that were so fatal in the old Marian operation. Indeed, I believe that no safe dilatation can be effected except by the finger, with which no harm can be done, whilst it appears to me that the greatest possible mischief may be done with screw-dilators.

Comparison between the Median and the Lateral Operations.—The two operations cannot with propriety be compared as a whole, as we have as yet no sufficient statistics to enable us to determine whether the mortality after the median has been less than that which has followed the lateral. We may, however, compare the modern median operation with the lateral, and endeavour to determine in what respects it is superior, in what inferior, to the lateral, and in what cases it might be employed instead of the latter. For in this, as in all other operations, the Surgeon should not be too exclusive; it is his duty to learn and to practise different methods of attaining the same end, and to make use of one or the other according to the requirements of the case before him.

In order to make a proper comparison between these two operations, we must take them *seriatim*. The difficulties and dangers of the lateral operation are: 1, the difficulty in some cases of entering the bladder; 2, hæmorrhage; 3, the risk of wounding the bulb; 4, of wounding the rectum; 5, too extensive an incision in the prostate, and opening up the pelvic fascia; 6, the difficulty in extracting the stone.

1. **General Ease and Simplicity of the Operation.**—There is no doubt that the Surgeon will be more skilful in that operation which he has more often performed: but, so far as ease and simplicity are concerned, there is no great difference between them. In the lateral operation there is very seldom any difficulty in entering the bladder, though Surgeons have sometimes been foiled in this; but Surgeons of the greatest skill have also had great difficulty in entering the bladder in the median operation. The bladder tends to be pushed upwards and backwards before the finger, especially in boys, in whom the prostate is not developed; and, unless the neck of the bladder be well opened, there appears to be great danger of tearing across the membranous part of the urethra, and of pushing backwards the separated bladder. In boys, the parts are so very small and undeveloped, and the space to work in is so very narrow, that an ordinary finger can only with great difficulty be got through the neck of the bladder unless this have been freely incised. But, by doing this, we depart entirely from the guiding principle laid down by the advocates of the median operation, viz., dilatation and not incision. So far as

facility of entering the bladder is concerned, the two operations are probably on a par in the adult : but in the boy the result of recent experience would show that the difficulties in this respect are far greater in the median than in the lateral ; so great, in fact, that the operation should never be performed.

2. **Hæmorrhage.**—In this respect, the median operation has decidedly the advantage. If the incision be made in the middle line, without wounding the bulb, although there may be tolerably free bleeding at the time, yet there is no vessel that can furnish dangerous consecutive hæmorrhage ; whilst in the lateral operation there are the dangers of arterial and of profuse venous hæmorrhage, the knife coming into close relation with the artery of the bulb and others of some size. If the object were, therefore, simply to save blood, the median is so far better than the lateral. But, after all, it must be said that the danger of excessive hæmorrhage in the lateral operation is small.

3. **Wound of the Bulb.**—This may occur in both, but is more difficult to avoid, and indeed is very likely to happen, in the median, as the bulb sometimes so overlaps the membranous part of the urethra, that it is impossible not to cut it ; whilst in the lateral operation, by cutting low down, and entering the groove of the staff well back, and from below upwards, this may often be avoided. It is true that division of the bulb in the mesial line seldom gives rise to much hæmorrhage ; but cases have occurred in which patients have died from this cause after perineal section.

4. **Wound of the Rectum.**—The gut is not in much danger in the lateral operation, unless it be distended. In the median, on the other hand, the rectum is in considerable danger. If this operation be performed on the dead body, it will be found that the back of the bistoury comes very, I may say uncomfortably, close to the finger in the rectum ; and if another finger be placed in the wound, they will come into very close apposition just anterior to the prostate. In the old Marian operation, the rectum used to be very frequently cut, gas and fæces issuing from the wound.

5. **Treatment of the Prostate.**—As to the difference in this respect—*i.e.*, dilatation in the median, section in the lateral operation—I believe it to be more imaginary than real. I think that it is very nearly the same in both operations when properly performed. All are agreed that in the lateral operation only a limited incision should be made in the prostate and neck of the bladder, the opening being dilated with the finger, so as to avoid opening up the pelvic fascia. The difference between an incision that opens the capsule of the prostate, and dilating this structure by the finger, is very great. The great object in lateral lithotomy is not to open up the pelvic fascia with the knife ; and it is difficult, if not impossible, to tear this with the finger. If we take an aponeurosis out of the body, it will be found to be very difficult to tear ; but if touched ever so lightly with the knife, it separates at once. So, in the median operation, the prostate may be dilated to a considerable extent without opening its capsule. I have used the word "dilate ;" but dilatation appears to me to be an erroneous term. I believe that the prostate is not simply dilated, but lacerated : that there is an actual laceration of the substance of the prostate, but not extending into or through its capsule. I have often examined the prostate in the dead subject, after it has been subjected to this process of "dilatation," and have always found its substance more or less torn. A laceration of the substance of the prostate, however, is of no consequence, and becomes dangerous only when it extends so far backwards as to

tear the lateral ligament of the bladder, when it exposes the patient to the fatal accident of extravasation of urine and diffuse inflammation of the pelvic fascia. Now, in the lateral operation, in running the knife down the groove of the staff, the Surgeon may readily, unless care be taken, and very often, I believe, does actually and almost unavoidably go beyond the limits of the prostate, and thus exposes the patient to all these dangers. In the median this cannot be done, if the knife be not used after the urethra is opened, the prostate being dilated solely with the finger. So far as this point, then, is concerned, the median may be regarded as safer than the lateral operation, it being *impossible* to open up the recto-vesical fascia with the finger in the median, whilst it *may* be opened by the knife in the lateral.

In fact, the neck of the bladder and the prostatic portion of the urethra are in the median operation placed very much in the position of the female urethra when that is dilated for the extraction of a calculus; being dilated to a great extent, and somewhat lacerated, but not torn through so as to admit urine into the sub-peritoneal cellular tissue of the pelvis; and in this I believe the superiority of the median over the lateral operation to consist.

6. **Manipulation of the Forceps and Extraction of the Stone.**—In the adult, the main difficulty of lithotomy does not lie in entering the bladder, but in the completion of the operation—the removal of the stone. And the difficulty and danger increase in proportion to the size of the calculus; the tissues between the neck of the bladder and the perineal integuments must either be widely cut or extensively torn and bruised to allow the passage of a large stone. No amount of simple dilatation of which these tissues are susceptible can make a passage through them that will allow the extraction of a stone 1½ inches in diameter; such a stone must either be cut or torn out. Now, what space have we in the median operation for the introduction of the forceps and the extraction of a large stone? Here, I think, is the weak point of the median operation. In it the incision is made, and all the manipulation is practised, towards the apex of the narrow triangle formed by the rami of the pubic bones. The base of this triangle is represented by a horizontal line corresponding to the level of the membranous portion of the urethra, and consequently does not occupy the widest part of the perinæum; it is formed by the lower portion of the triangular ligament, the space behind it being filled up by the rectum and its muscles, and the ischio-rectal fat. The ligament forms a barrier stretching across the perinæum, which cannot be depressed, and requires to be divided laterally into the ischio-rectal fossa before a stone of any considerable magnitude can be removed. It was in consequence of the extensive bruising and laceration of these structures, and the difficulty experienced in bringing the stone through them, that the old Marian operation fell into disuse.

In performing the median operation there are three points, or rather planes, of obstruction, between the surface and the interior of the bladder. The first is occasioned by the muscles of the perinæum, and, perhaps, also by the under portion of the deep perineal fascia. In the lateral operation we cut across this plane, and lay open the ischio-rectal fossa, giving abundance of room for the manipulation of the forceps and the extraction of the stone, along the base of the triangle formed by the rami of the ischium and pubes. But in the median we have to extract towards the summit of this space, at the apex of a narrow triangle, having the muscular structures forming a tense bar along its base, and offering a material obstacle to the introduction of the forceps and the extraction of the stone.

The second obstacle lies in the prostate ; but, as it is easily removable by dilatation, it cannot be considered a serious one.

The third, the deepest and most important, is situated at the neck of the bladder. We find here a narrow tense ring beyond the prostate ; and this bar remains intact in spite of the dilatation and laceration to which the prostate has been subjected. On introducing the finger, we shall feel it grasped tightly by this ring. I have found, by experiments on the dead subject, that this inner ring of the neck of the bladder cannot be expanded to a size more than sufficient for the extraction of a calculus of one inch in diameter without laceration or incision : and its laceration or rupture is well known to be one of the most dangerous and fatal accidents in lithotomy. It is in consequence of the obstacle offered by this, that the median operation is not available for the extraction of large calculi. A calculus over one and a half inches in diameter cannot be extracted by the median operation without the employment of great violence. But, though much force is usually required in order to extract a calculus of even moderate size through this tense ring at the neck of the bladder, it is an undeniable fact that serious consequences seldom follow the violence so used, and that a degree of force, which would be fatal in lateral lithotomy, may be employed without danger in the extraction of a calculus by the median operation. In this respect the extraction of a calculus by the median operation resembles the removal of one through the dilated urethra of the female ; the great point in favour of the median over the lateral procedure, and the cause of its comparative safety, being that the lateral true ligament of the bladder is not incised, nor otherwise opened. But, it may be said, what is easier, when the finger is in the bladder, than to push a probe-pointed bistoury along it, and cut downwards and outwards through these structures into the ischio-rectal fossa, if the stone be large, and thus get plenty of space ? Nothing could be easier or more simple ; but what would be the consequence ? We at once reduce the median to the conditions of the lateral operation. A free incision in the neck of the bladder and prostate increases the tendency to hæmorrhage, opens up the fascia, and exposes the patient, in fact, to all the dangers of an ill-contrived lateral operation, destroying at once and altogether the principle of the median operation—viz., dilatation and not incision ; and, if we do not gain space by incision, but attempt to extract a moderately large stone by dilatation of the parts, we shall certainly not succeed, but our dilatation will end in a laceration, not only of the substance of the prostate, which is safe, but of the neck and perhaps of the base of the bladder, which will be fatal.

In conclusion, then, it appears to me that the median operation, when performed in suitable cases, has the advantages over the lateral of being attended by less risk of arterial hæmorrhage, and less danger of injury to the lateral ligament of the bladder but, that in consequence of the very small size of the opening that can be made in the bladder by it, *provided these advantages are maintained*, it is applicable only to stones of at most a medium size, and that it cannot in all cases be substituted for lateral lithotomy, as the general operation for stone, where lithotrity is not admissible.

Indications for the Median Operation.—Median cystotomy may with propriety be performed in the following classes of cases. 1. In cases in which foreign bodies, such as pieces of bougies, of tobacco-pipe, &c., are lodged in the bladder and an attempt to remove them with a lithotrite has failed, the median operation is preferable as a large opening is not required. 2. In very exceptional cases in which lithotrity is impracticable on account of acute cystitis or some other complication, the median operation may be performed when the stone is under one inch in its longest diameter. 3. If there are very numerous small stones, and for any reason lithotrity be thought inadvisable, the median operation is the best. 4. It was formerly practised occasionally to remove fragments which would not pass after lithotrity, but with the improved means at our command now for washing out the bladder this can scarcely ever be necessary. In fact the improvements in lithotrity have almost displaced the median as an operation for stone. The bladder is, however, now frequently opened in exactly the same way for digital exploration and removal of tumours.

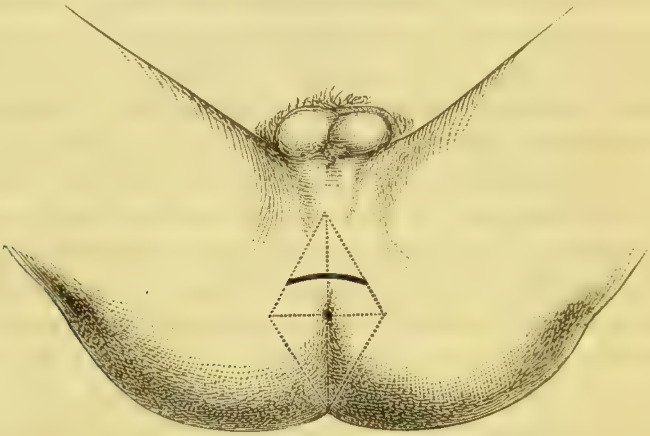


Fig. 892.—Line of Incision in Bilateral Lithotomy.

Under any circumstances, for the reasons already given, it is not applicable to children, and it is never safe if we have to do with a large stone.

Bilateral Lithotomy.—In the bilateral operation introduced by Dupuytren, a curved transverse incision is made across the perinæum half an inch above the anus, towards which its concavity looks, the horns of the incision extending to two-thirds of the distance between the anus and the tuber ischii on each side (Fig. 892). The dissection is carefully carried down to the central point of the perinæum, and the membranous portion of the urethra is opened on a grooved median staff previously introduced; along this the double *lithotome caché* (Fig. 893) is passed with its concavity turned upwards. The Surgeon, having well assured himself that the instrument is fairly in the bladder, turns it so that its concavity looks down towards the rectum; the

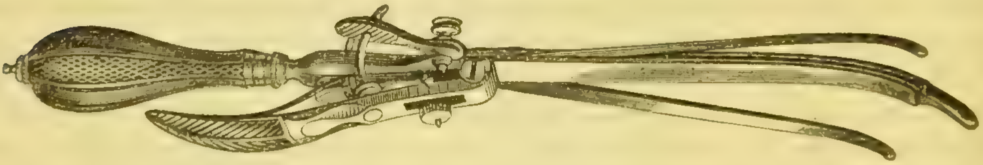


Fig. 893.—Dupuytren's Lithotome Caché, Opened.

spring in the handle is then pressed, and the blades expanded to a proper distance previously regulated, and both lateral lobes of the prostate divided to a corresponding extent downwards and outwards in withdrawing the instrument (Fig. 894). The extraction of the stone is then effected in the usual way. This operation appears to me not to have received the attention that it deserves from Surgeons in this country. By being careful to introduce the lithotome into the membranous portion of the canal, the arteries of the bulb are not endangered, and indeed the tranverse and superficial arteries of the perinæum are also above and beyond the line of incision. The prostate is divided equally on both sides in its greatest diameter ; if the expansion of the lithotome be carefully guarded, there is no danger of going beyond the limits of that organ, or of wounding the internal pudic arteries (Fig. 895) ; and the interior of the bladder is reached by the most direct and readiest passage. In withdrawing the lithotome, the handle must be well depressed, and great care must be taken that the instrument be kept accurately in the mesial line, so that the section may not be made more freely on one side than the other.

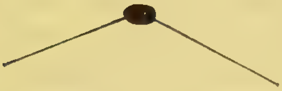


Fig. 894.—Bilateral Section of Prostate.

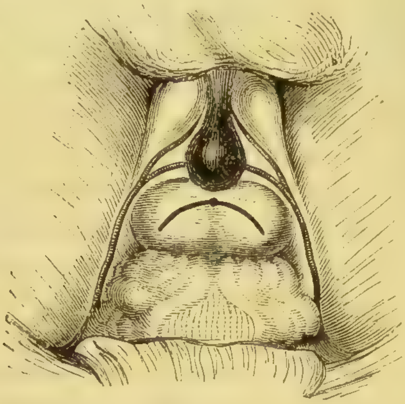


Fig. 895.—Line of Incision in the Prostate in Bilateral Lithotomy, showing its relation to the Bulb and the Internal Pudic Artery.

The operation has not been performed with sufficient frequency in this country for any reliable statistics as to the results ; but Eve of Nashville has done it in 78 cases of all ages, with only 8 deaths.

Medio-Bilateral Operation.—Civiale recommended a combination of the median and the bilateral operations of lithotomy. This operation is easy of execution, and has been performed for the extraction of stones too large for the ordinary median operation.

The operation may be performed in the following manner. The patient having been tied up, and a deeply grooved rectangular staff passed into the bladder, the urethra is opened at the membranous part with the edge of the knife turned upwards, as described in the median operation (p. 1030) ; the double lithotome is then slid along the staff into the bladder, its concavity turned downwards, the blades expanded to but a limited extent, and the prostate and the soft structures between it and the surface incised as it is withdrawn, or the bilateral gorget (Fig. 896), invented by J. Wood, of New York, may be pushed along the staff. If the stone be not very large, the incision may be confined to one side only, and made with a probe-pointed bistoury. It will be found that sufficient space is obtained by the perpendicular incision of the skin; whilst the limited internal transverse cut removes that tension and resistance of the deeper structures, which in the ordinary median operation interfere seriously with the manipulation of the forceps and the extraction of the stone; and by the division of both sides of the prostate to a limited extent, abundance of space is obtained. Experience has shown, however, that the advantages are rather theoretical than practical, and its performance in this country has not been attended with satisfactory results; two of the principal dangers being wound of the rectum, and tearing through the sphincter.

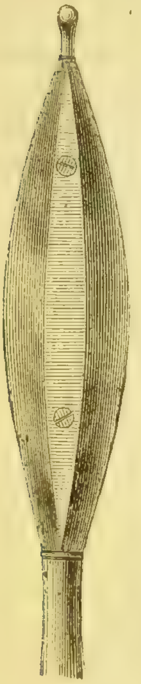


Fig. 896.—Wood's Bilateral Gorget.

Many other modifications of the median and the bilateral operations have been practised by varying the direction of the external incision, and by making the internal one on one or both sides of the prostate, or by notching this structure in various directions.

Recto-vesical Lithotomy.—This operation was suggested by Sanson in 1847, as a means of removing large stones and avoiding the dangers of hæmorrhage, but the results have not been such as to justify its performance in preference to other methods. It is thus performed. A staff grooved on its convexity is passed into the bladder, the finger is then passed into the rectum, and the part of the staff lying in the membranous portion of the urethra felt for; a knife, with its edge directed forwards, is then passed along the finger into the groove of the staff and withdrawn, dividing the internal and external sphincters and the skin at the margin of the anus; it is then reintroduced with its edge directed downwards, and run along the groove of the staff, dividing the prostate and notching the neck of the bladder, and the stone is then extracted in the usual way.

The High or Suprapubic Operation.—The operation of suprapubic lithotomy was first performed by Pierre Franco in 1560 at Lausanne. He had commenced to cut a child by the apparatus minor, when he found the stone to be of the size of a hen's egg, and too large to be extracted by the perinæum. The parents insisted, however, that it should be removed in some way, and seeing the stone forming a prominence above the pubes when pushed forward from the rectum, Franco cut down upon it and successfully removed it. He did not, however, repeat the operation, and suprapubic lithotomy cannot be said to have become a recognized surgical proceeding till the early part of the eighteenth century, when it was practised and perfected by Douglas and Cheselden. The results obtained were certainly better than those of the operation by the apparatus major, then chiefly in vogue; but after the perfection of the lateral operation by Cheselden, suprapubic lithotomy again went out of fashion, being reserved only for those cases in which the stone was too large to be extracted by the perinæum. The objections to the operation were its tediousness and painfulness, and the dangers of wound of the peritoneum and urinary extravasation. Lately the operation has been again revived, at first with the idea that by antiseptic treatment the wound in the bladder could be closed by sutures, and union by first intention obtained. The revival of the operation has led to improvements in the details of its performance, and some Surgeons have advocated its adoption, even in children, in preference to the lateral.

Operation.—The high operation consists in making an incision through the abdominal wall, above the pubes, and opening the anterior part of the bladder below the reflection of the peritoneum. In order to do this safely it is necessary to raise the apex of the bladder, and with it the peritoneum, as high as possible above the pubes. This was formerly done by distending the bladder with water before operating, but in 1878 Garson showed by experiments on the dead body that by injecting the rectum at the same time, the whole bladder could be pushed upwards so as to become an abdominal rather than a pelvic organ, and the reflection of the peritoneum was carried from two to three inches above the pubes. In 1880, Petersen, of Kiel, independently arrived at the same conclusion, and practically applied it to suprapubic lithotomy by introducing an india-rubber bag into the rectum, which was distended with water before commencing the operation.

The operation is thus performed. The patient should lie flat on a table. His legs should not hang over the end, as over-extension of the thighs makes the recti tense. The shoulders should be slightly raised by a pillow. The pubes is first shaved and the whole region rendered aseptic by washing with soap and water and afterwards with carbolic lotion (1 in 20) or perchloride of mercury (1 in 500). A soft catheter is then passed, to which an india-rubber tube is attached with a funnel at the end. Through this a concentrated cold solution of boracic acid, warmed to the proper temperature, is poured into the bladder, and withdrawn again by lowering the tube below the table. In this way the bladder must be repeatedly washed out. Finally, by raising the funnel from two to three feet above the body the bladder may be sufficiently distended if the patient be fully under the anæsthetic. Forcibly injecting a fixed amount into the bladder is not free from danger, and has been known to cause rupture. The catheter is now withdrawn, and an india-rubber band or a piece of tape fastened round the penis to prevent the escape of the fluid. If it be preferred the bladder may be injected through a metal catheter, which may be plugged and left in as a guide to the bladder. The rectal bag is now inserted after being well oiled. Petersen's bag is pyriform in shape, having a long tube attached to its apex, by which it is distended with water. The quantity injected must not exceed ten ounces in the adult. In children three to four ounces is usually sufficient. Too much force must not be used, as it has happened that the rectum has been burst by so doing. Sir W. MacCormac recommends a sausage-shaped bag as more closely resembling the natural form of the rectum.

The bag being distended, the bladder can now be distinctly felt as a rounded swelling above the pubes. The Surgeon may stand on whichever side he prefers, but the left will be found most convenient in the later stages of the operation. No special instruments are required in the operation. The incision is made accurately in the middle line. It should be from two to four inches in length, according to circumstances, the longer incision being necessary when the patient is very fat. It should extend over the pubes at its lower end for about half an inch. The pyramidales, if present, are drawn apart, and if necessary notched. The linea alba is cautiously divided near the pubes, and the incision carried upwards on a director to the upper end of the wound. The transversalis fascia may then be recognized and divided.

The wound should now be held widely open with retractors. A varying amount of fat is exposed, which must be carefully dissected through with two pairs of forceps, or a director and the forceps. Sir H. Thompson employs a pointed ivory instrument. If the knife be used, and even sometimes with blunt instruments, there may be very troublesome hæmorrhage from some large veins which lie in this region. After carefully separating the fat and pushing it somewhat upwards, so as possibly to raise the reflection of the peritoneum, the bladder comes into view. If an instrument have been retained its handle may be depressed so as to make its point project, pushing the bladder before it. The bladder is recognized in the adult by its muscular fibres; in children, Dulles states that its bluish-grey colour is characteristic. The bladder having been fully exposed and recognised, the next point is to secure it before an opening is made. Unless this be done it will collapse as soon as it is punctured, and sinking down in the pelvis, may only be recovered with difficulty. The safest method of securing it is to pass two silk stitches through its muscular coat, so as to obtain a firm hold on each side of the middle line. If the coats are thin, or if it be not intended to suture the bladder after the operation, the threads may include the mucous coat also. Some Surgeons prefer introducing a couple of tenacula instead of the threads. The bladder being thus secured, and the muscular fibres being clearly visible, showing that it is not covered by peritoneum, a scalpel is thrust into it with the back directed upwards, and an incision of sufficient size to admit the finger is made downwards towards the pubes. The finger is then inserted, and the size of the stone ascertained. If it be small it may at once be seized and removed in an ordinary pair of lithotomy-forceps. If it be larger the wound must be carefully enlarged downwards with a probe-pointed bistoury. It is better to do this by cutting rather than by stretching or tearing, as there is but little bleeding, and if it is intended to suture the bladder the wound should be made as cleanly as possible. Sir H. Thompson finds that in many cases the stone may be conveniently removed between the two forefingers, the others being locked together so as to convert the two hands into a kind of forceps. If the contents of the bladder are so foul that it is doubtful whether the washing has rendered the cavity aseptic, it is well to wipe the wound over with chloride of zinc (40 gr. to ℥j), and to dust it with iodoform before making the incision into it. The stone having been extracted, the bladder may be cleaned with a sponge to remove any clots of blood. If the bladder wall be thick and healthy and its contents free from decomposition, an attempt may then be made to close the wound by fine carbolized silk or catgut sutures. To do this a stitch must first be passed beyond the upper part of the wound, taking a hold on the muscular coat only on each side of the line of the incision. By means of this the bladder can be drawn up while a series of stitches are inserted about a sixth of an inch apart in the same way as in Lembert's suture of wounded intestine. The last stitch must be beyond the lower end of the wound. The two stitches beyond the wound, above and below, are essential to prevent leakage. The bladder is then tested by distending it again with the boracic acid solution, and its cavity is at the same time washed free from blood. If the bladder wall be very thin, if there is much cystitis, and especially if in the case of a large stone the edges of the wound have been bruised during extraction, no attempt should be made to close the vesical opening by sutures, as it will certainly fail. Even when the bladder is healthy, suture fails in more than half the cases, and for this reason many Surgeons never attempt it. If the opening is not closed by sutures a good-sized india-rubber tube should be inserted, reaching well towards the fundus of the bladder.

The treatment of the external wound varies with that of the bladder. If the vesical opening has been closed by sutures a drainage-tube must be inserted at the lower end of the external wound, and the upper part may be closed and an antiseptic dressing of some kind applied. By this means an exit is left for the urine if the sutures give way. If a tube is inserted into the bladder the external wound may be left open or its upper part closed, according to its size. The strictest antiseptic precautions should be observed throughout the operation.

In the after-treatment, if the bladder has been closed by sutures, especially in children, the patient may be allowed, if he can, to pass water naturally. If, however, it be long delayed so that distension of the bladder is to be feared, a catheter must be passed. If a drainage-tube has been inserted into the bladder from the wound, the urine will escape readily from it, and should be received in a large sponge, changed every hour and carefully washed in carbolic acid lotion (1 in 40). The patient may lie on one side to facilitate drainage. The tube may be removed after three or four days.

Other means of drainage have been adopted. Thus a soft rubber catheter may be tied into the urethra, and a long tube applied to it to maintain drainage; but this is apt to cause urethritis, and is perfectly useless if the bladder wound is freely opened. Perinæal incisions have been made, but these are always not only needless but injurious. The best mode of treatment is not yet certainly determined; but probably the wisest course is only to suture the bladder in well-selected and favourable cases, and then to leave the external wound partly open in case of failure. In all other cases drain from the wound with a good-sized rubber tube retained for three or four days.

The **special dangers and difficulties of the operation** are very few. Hæmorrhage from veins superficial to the bladder is avoided by using a blunt instrument after opening the transversalis fascia. Wound of the peritoneum is the most serious accident that can happen, and if it occurs before the bladder is opened the operation should be abandoned and repeated at a subsequent time if possible. It is avoided by the proper distension of the rectum and bladder, and by making the opening downwards towards the pubes, and by seeing the muscular fibres of the bladder clearly before the incision is made. Rupture of the bladder or rectum by too forcible injection is not likely to happen if the operation is performed as above described.

The **dangers after the operation** are various. Extravasation of urine into the loose tissue around the bladder is perhaps the most serious and fatal. It is best prevented by disturbing the tissue as little as possible during the operation, especial care being taken not to make a cavity with the finger between the symphysis pubis and the bladder. If the wound be not closed too tightly and if good drainage be maintained the danger of extravasation is very small. Secondary hæmorrhage is very rare, and should it occur it is the consequence of ulceration of one of the large veins superficial to the bladder. Septicæmia and pyæmia are not more common than in other operations on the urinary organs, and are best prevented by the strictest attention to antiseptic details during the operation, and the adoption of some antiseptic treatment afterwards. The formation of an urinary fistula practically never occurs. Death from kidney disease is of course an occasional occurrence, as in all operations on the urinary organs ; but there is no special liability to it in suprapubic lithotomy.

Results.—The older statistics are of little value, partly because until the recent revival of the operation it was only undertaken when the size of the stone or some other complication made the perinæal methods impossible, and partly because the older operations were undertaken without the advantages of antiseptics, and without the present means of raising the bladder and its peritoneal investment above the pubes, and usually without efficient drainage. Dulles of New York, a strong advocate of the operation, collected a total of 465 cases in both sexes ; of these 135 died, or 1 in 3·44. He found that for calculi under one ounce it contrasted very unfavourably with the lateral, for those between one or two ounces there was little difference, whilst for calculi above one ounce it gave by far the best results. Later statistics by Dennis of New York, and by Sir W. MacCormac give much better results. Thus of 124 cases operated on since 1879 collected by Dennis, only 18 died, or 1 in 7 ; but of these deaths 7 might fairly be eliminated as having no direct connection with the operation. MacCormac collected a total of 91 operations performed in this country from January 1st, 1885, to March, 1887. Of these 57 were adults, of whom 18 died, or 1 in 3·1. Only one patient died from peritonitis, and none from urinary extravasation or pyæmia. The cause of death in one case was rupture of the rectum by the bag. In 33 cases the patients were under 15, and not one died. The stones in the adults varied from 24 ounces to 10 grains in weight, and in the children from 2¼ ounces to 35 grains. The bladder was sutured in 18 children, with 8 successes, and in 8 adults with only 2. In one case the operation had to be abandoned owing to the peritoneum covering the bladder as low as the pubes. Sir Henry Thompson also reports most favourably of the operation in its present form.

Comparison of the Lateral and Suprapubic Operations.—In the first place it seems probable that at the present time when all stones of moderate size in the adult are removed by lithotrity the suprapubic operation is safer for the residue than the lateral. In children the lateral operation is so successful that it seems doubtful whether it can be excelled by the suprapubic; but from the recent statistics of Sir W. MacCormac it seems that it will at least be equalled by it. As to ease of performance the suprapubic probably has the advantage both in children and adults. The time occupied in the high operation is of course much longer, but that is not a matter of great consequence when the patient is under an anæsthetic. The danger of hæmorrhage is decidedly less in the suprapubic, although that operation is not free from it. The high operation is adapted to stones of all sizes, while the lateral becomes extremely dangerous when the calculus exceeds two ounces in weight. It is not interfered with by deformities of the pelvis, ankylosis of the hips, or enlargement of the prostate, all of which may render the lateral difficult or impossible. Lastly, the lateral operation is said, especially in children, to leave the patient sterile, from injury to the ejaculatory ducts. This is very doubtful, and cannot be said to have much weight in the argument. It would appear, therefore, that the suprapubic, as at present performed, contrasts favourably with the lateral on almost every point. The revival of the high operation has been the most prominent feature in the history of lithotomy during the last ten years. The operation is now being extensively practised in all parts of the world, and especially in America; but it remains to be seen whether Dennis's prophecy will be fulfilled, "that the time is not far distant when there will be practically only two operations for stone in the bladder, suprapubic lithotomy and lithotrity."

CHAPTER LXIX.

URINARY CALCULUS (*continued*).

LITHOTRITY.

THE operation of **Lithotrity**, by which the stone is crushed in the bladder and the fragments expelled or extracted through the urethra, is of modern invention; for, though various rude attempts may at different times have been made with this view, it was not until about the year 1818 or 1820 that the subject began to attract serious attention; and to the French Surgeons is undoubtedly due the great merit of having introduced this operation. About this time Civiale, followed by Amussat, Leroy, and others, began constructing instruments, which, though very imperfect, yet were sufficient to break down a calculus in the bladder. This was publicly done by Civiale in 1822. From this period lithotrity made rapid progress; and the successive improvements made by the Surgeons whose names have just been mentioned, together with the ingenious mechanical adaptations introduced by Charrière and Weiss, enabled Surgeons to attack the stone with certainty and effect.

The importance of lithotrity was urged upon the profession by Civiale, Amussat and Heurteloup in France and Brodie and Costello in this country. The practice thus established by these Surgeons has from time to time been improved by the ingenuity of others, amongst whom Sir William Fergusson, William Coulson and Sir Henry Thompson are conspicuous. Up to the year 1878 the operation of lithotrity was practised on the lines originally laid down by Civiale and Brodie, the main features of which were to crush the stone by repeated operations, each limited to a few minutes, and to allow the fragments to pass by the natural efforts of the patient. In 1878, however, Bigelow of Boston demonstrated that it was possible to break the stone up at one prolonged operation, and completely to wash out the fragments at the same time through a large catheter or evacuator. To this method of operating he gave the name of "Litholapaxy," but its enormous advantage over the older methods was so quickly recognized, and it so speedily became universally adopted, that the distinctive name is now seldom used, and when we speak of lithotrity we mean crushing the stone and removing the fragments at the same time by Bigelow's method. By this great improvement Bigelow not only reduced the sufferings of the patient and the dangers of the operation, but made it applicable to much larger stones than could possibly be removed by the older method.

Instruments.—The instruments required for lithotrity are the following:

An ordinary **sound** with a short beak is required to examine the condition of the bladder. The steel sound should be hollow, so that the bladder may, if necessary, be injected through it after or during sounding, without the necessity of changing the instrument (Fig. 897). This will be found of much service in the later stages of the operation for detecting small fragments.

A **brass syringe** should be at hand with which the bladder may be injected if necessary.

An Otis's **Urethrometer** is often useful, by which the size of the passage can be measured as a guide to the evacuator to be used.

Some large-sized **conical steel bougies**, from 12 to 18 of the English scale, are of great use in measuring and dilating the passage before inserting the lithotrite or the large evacuator.

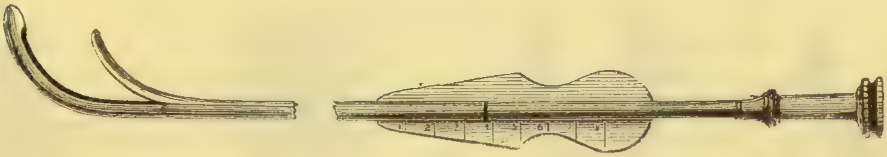


Fig. 897.—Lithometer Sound for measuring Stone. It is hollow, so that the bladder can be emptied and injected through it.

The instrument for breaking the stone is called a **lithotrite.** This has undergone various modifications and improvements at the hands of Mechanicians and Surgeons. To Weiss in this country, and to Charrière in France, we are especially indebted for having brought it to its present state of perfection. In the earlier days of lithotrity the thumb-screw lithotrite was generally used (Fig. 898). Sir W. Fergusson invented a rack-and-pinion instrument, which, however, found little favour with Surgeons. Civiale's instruments, having the double action of screw and hand pressure, were those to which many gave the preference until the invention of the cylindrical handle by Thompson.

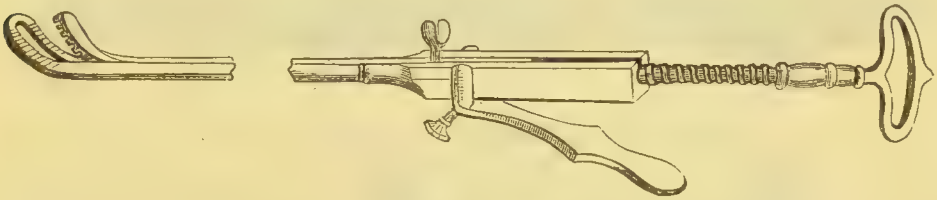


Fig. 898.—Weiss's old Thumb-screw Lithotrite for breaking the Stone.

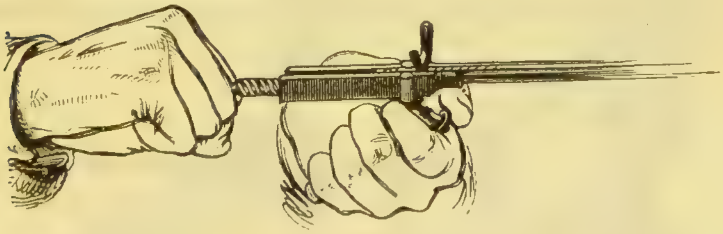


Fig. 899.—Position of Hands in using Thumb-screw Lithotrite.

The lithotrite must be made of well-tempered steel; and should be tested by being made to crush a piece of sandstone grit, of about the size of a walnut. It should be of as full a size as the urethra will readily admit; it must have the male blade well serrated, and the female or under blade pierced at its root by an oval aperture, through which the detritus of the crushed stone is forced, and thus any jamming of it in the angle between the blades is prevented. The female blade should be considerably wider than the male to avoid nipping of the mucous membrane of the bladder.

The larger lithotrites, intended to break stones of considerable size, are made with a fenestra in the female blade (Fig. 898); those intended to crush small fragments with a broad blade without a fenestra (Fig. 904).

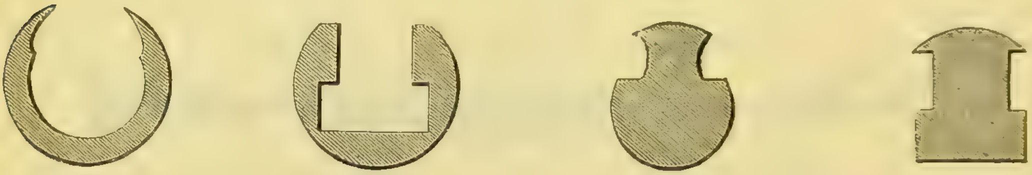


Fig. 900. Fig. 901. Fig. 902. Fig. 903

Sections of Lithotrites.

The lithotrite should be cut out of a bar of solid steel, and not, as is the case with some instruments, made of a plate of this metal, turned up at the edges; as such a one possesses too little strength to be used with safety on large and hard calculi. Those cut out of a bar of metal have an external blade, having a grooved shape, as in Fig. 901. In this, the male or internal branch, cut to fit accurately (Fig. 903), slides smoothly, the whole instrument possessing an amount of strength and power that no calculus can resist. The bent-up instrument is composed of an outer tube of metal, as represented in its transverse section (Fig. 900), in which the internal blade fits less accurately (Fig. 902), and which possesses less strength, especially at the elbow, than the lithotrite cut out of solid steel. The scoop, however, may without danger be constructed of bent metal.

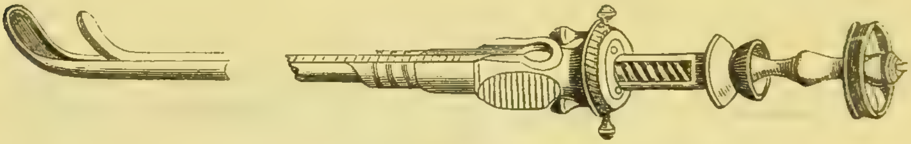


Fig. 904.—Civiale's Lithotrite for Crushing Fragments.

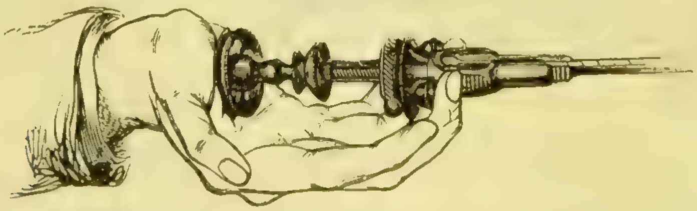


Fig. 905.—Position of Hand in using Civiale's Lithotrite.

Civiale's lithotrite, such as is represented in Fig. 904, has a most ingenious double action, enabling the Surgeon to work it either by the pressure of the hand or by a screw. In this instrument, there is no fenestra in the female blade. It is of two kinds. In one, the male blade is much narrower than the female; in the other, it is nearly as broad. The first kind is useful in crushing through moderate-sized stones; the second kind, with the broad male blade, is used in completely crushing and removing the detritus of small calculi, and the large fragments into which a stone has been broken by the open-bladed lithotrite.

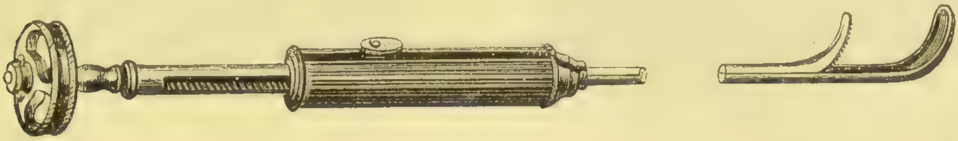
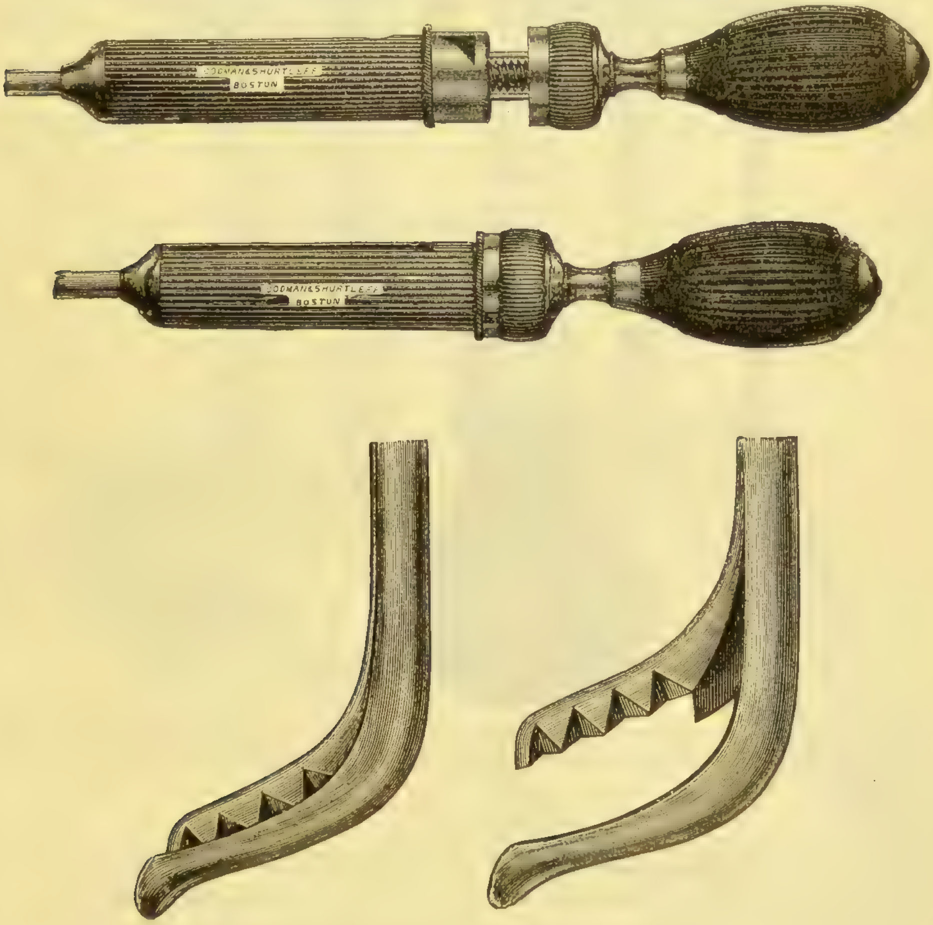


Fig. 906.—Thompson's Improved Lithotrite.



Figs. 907, 908, 909, 910.—Bigelow's Lithotrite.

Thompson's lithotrite (Fig. 906) somewhat resembles Civiale's in its action, but is more handy. The handle of the female blade is round, which gives the operator a better grasp of the instrument, and the sliding movement is converted into a screw action by drawing up the button on the handle with the thumb of the right hand without relaxing the grasp of the left on the handle.

Bigelow has introduced several modifications in the lithotrite. For large stones he had constructed instruments larger, heavier and more powerful than any previously in use. The handles are large and massive, and oval in form to fit the hand. The blades are somewhat longer, and the female blade has a long blunted point, curved towards the floor of the urethra, so as to protect the membranous part, against the roof of which the point of the instrument is directed as it passes through. The sliding is converted into the screw movement by twisting the cap shown in the figure with the right hand. These very massive instruments are only required for large and hard stones which it would formerly have been considered unwise to crush. For smaller stones Bigelow uses instruments of the ordinary size.

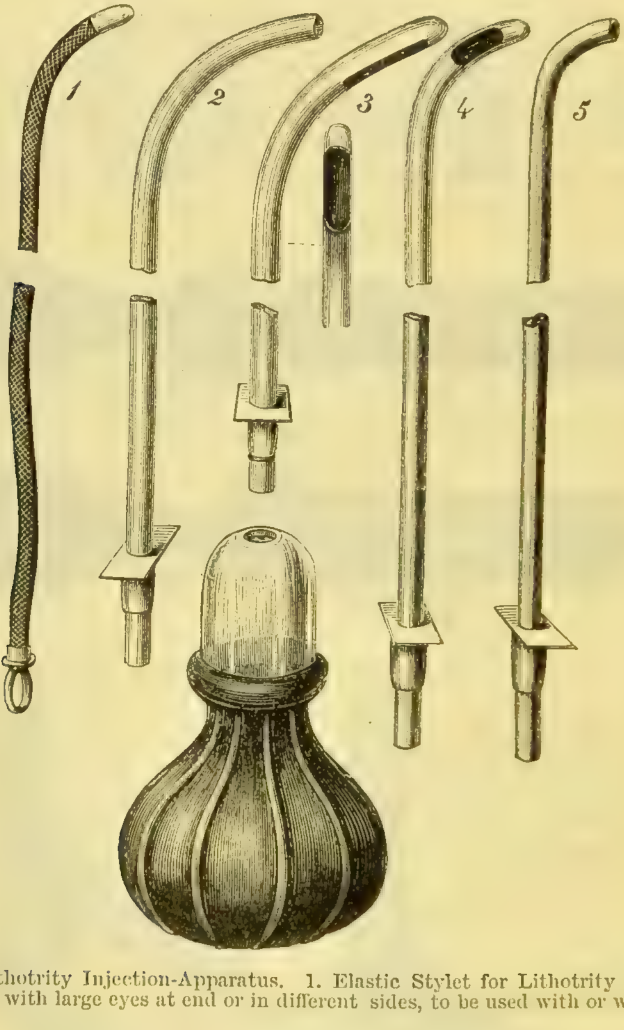
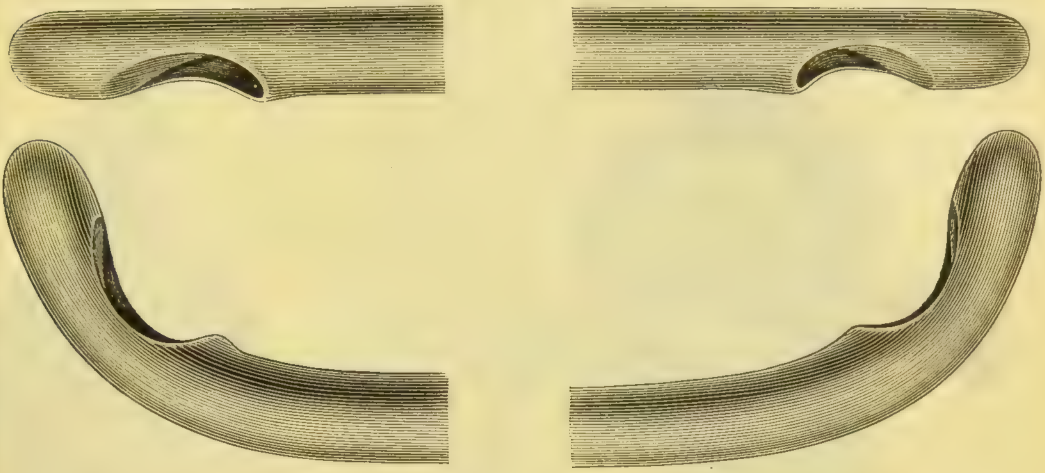


Fig. 911.—Clover's Lithotrity Injection-Apparatus. 1. Elastic Stylet for Lithotrity Catheter. 2, 3, 4, 5, Lithotrity Catheters with large eyes at end or in different sides, to be used with or without the Injection Apparatus.

After the stone has been crushed the **evacuator** is required to remove the fragments. This consists essentially of a powerful india-rubber bottle which can be connected with a large catheter. The bottle is emptied into the bladder by squeezing, and when the pressure of the hand is removed it sucks the fluid back with considerable force, bringing out at the same time the crushed fragments of the stone. In all forms of evacuator a glass vessel is attached to the lowest part of the bottle, into which the fragments gravitate.



Bigelow's Catheters, Full Size.

Fig. 912.—Bigelow's Straight Catheter.

Fig. 913.—Bigelow's Curved Catheter.

More than twenty-five years ago Clover invented a simple instrument which may be considered the parent of the evacuators now in use (Fig. 911). It was provided with a number of catheters open at the end or having large eyes.

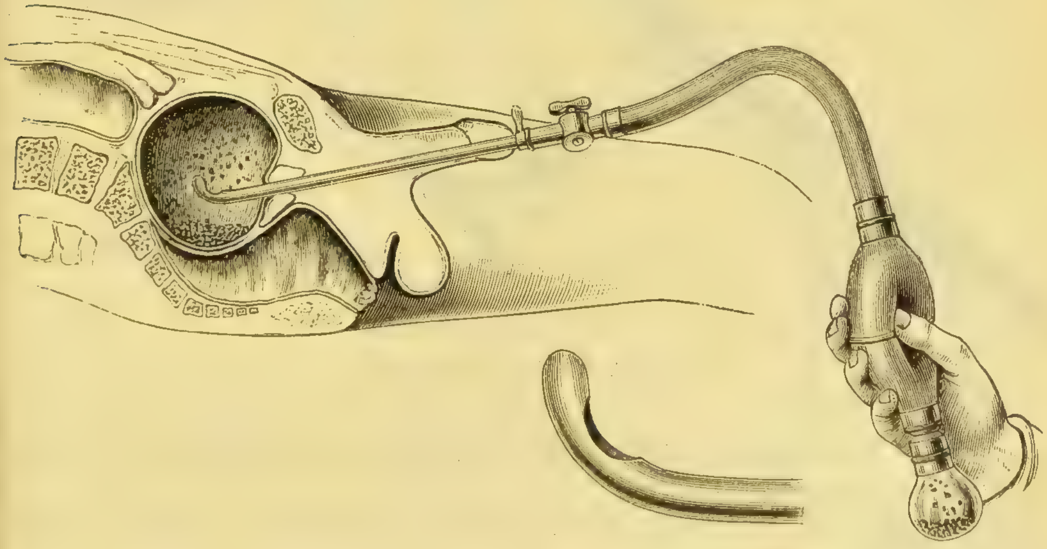


Fig. 914.—Removal of fragments of Stone by Bigelow's original Evacuator. Below, point of one of Bigelow's Catheters.

When passing the open-ended catheter a gum elastic stylet with a round metal point was introduced. The instrument was intended to wash out the detritus and smaller fragments after each operation, but did not meet with the favour it deserved, partly owing to its inefficiency from the weakness of the rubber bottle commonly provided.

In Bigelow's instrument the catheters are much larger than in Clover's, No. 29 French (18 English) being the largest size. The eye is very large and is placed in the front of the instrument close to the end. The catheters are of different forms, the most convenient being one with a short curve like that of a sound. A perfectly straight instrument is also often very useful, and is preferred by Bigelow.

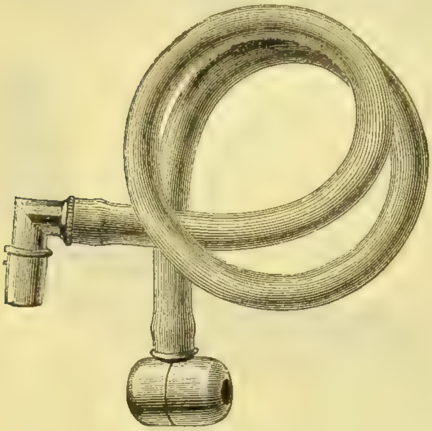


Fig. 915.—Tube for filling the Evacuator.

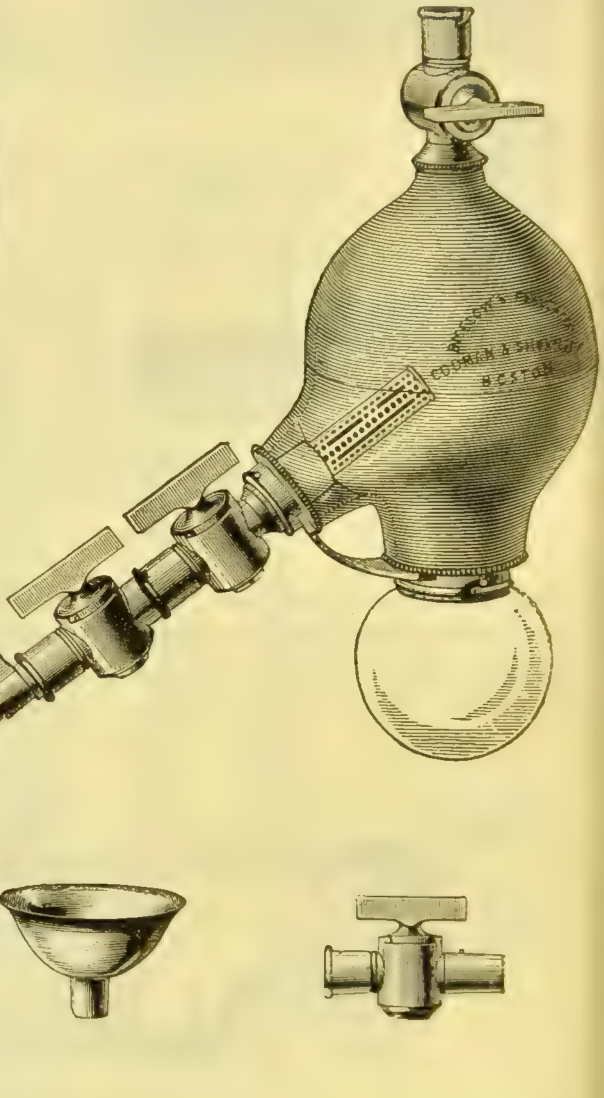


Fig. 916.—Bigelow's Evacuator.

The actual size and shape of the evacuating catheters most commonly used is shown in Figs. 912 and 913.

The various modifications of the evacuator are represented in the accompanying figures, which speak for themselves. Fig. 914 represents Bigelow's original evacuator, which I have myself found extremely efficient. He has, however, abandoned it for the improved form represented in Fig. 916. By turning the stopcock connected with the catheter and fixing the india-rubber tube shown in Fig. 915 to the cock at the apex of the bottle, the contents may be expelled and fresh water drawn in without disconnecting the bottle from the catheter. I have to thank Professor Bigelow for furnishing me with the accompanying woodcuts, which represent the latest instruments used by himself. Modifications of Bigelow's evacuator suggested by Sir H. Thompson and Otis are shown in Figs. 917 and 918.

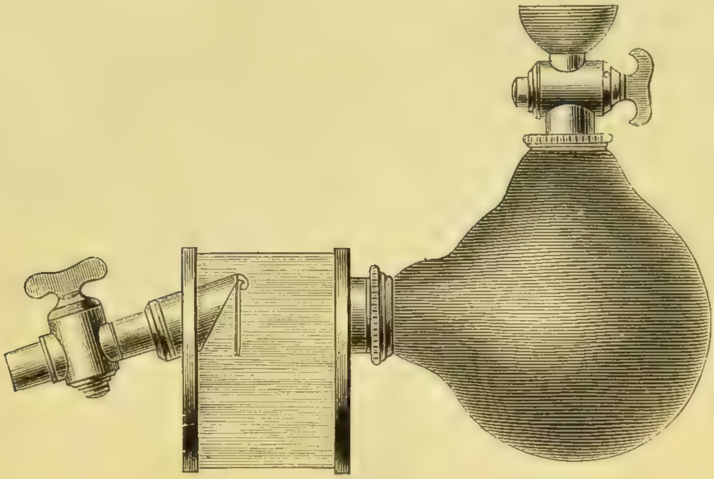


Fig. 917.—Sir H. Thompson's Improved Evacuator.

Preparation of the Patient.—Before proceeding to the operation of lithotrity, it is necessary that the patient's constitution should be carefully attended to; the bowels should be freely opened, and the condition of the digestive organs regulated, and, more especially, all local irritability about the urinary organs should be subdued by ordinary medical treatment. This is even of greater importance than in lithotomy, as the prolonged mechanical disturbance to which the bladder is exposed may aggravate any existing cystitis. The urine should be carefully examined, and the condition of the kidneys ascertained as far as possible. In a subsequent part of this Chapter, when we come to the comparison of lithotomy and lithotrity, we shall examine the conditions which either indicate or negative the performance of the latter operation. At present, we will suppose a case in which the Surgeon may have recourse to lithotrity with every prospect of readily and permanently ridding the patient of his calculus.

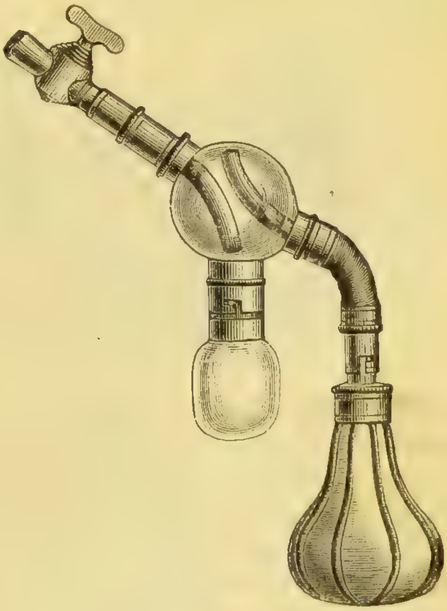


Fig. 918.—Otis's Evacuator.

Use of Anæsthetics.—In former times many Surgeons habitually performed the operation without an anæsthetic, believing that the sensations of the patient were a useful guide to the Surgeon, helping him to avoid nipping or otherwise injuring the bladder. For the success of the present method of operating an anæsthetic is essential, both to enable the Surgeon to continue the operation till the stone is completely crushed, and to facilitate the subsequent washing out of the fragments.

Operation.—The operation of lithotrity may be divided into four stages: 1. The introduction of the lithotrite; 2. The search for and seizure of the stone; 3. The crushing of the stone; and 4. The evacuation of the fragments.

As a **preliminary step before the operation,** Bigelow recommends that the urethra be measured with Otis's urethrometer, in order to ascertain the size of the evacuator that should be used. Sir H. Thompson recommends the passage of a large conical steel bougie, which answers the same purpose, and at the same time slightly dilates the canal. The bougies passed should be from Nos. 14 to 18 of the English scale at the thickest part. With a urethra admitting No. 16 no difficulty need be anticipated in the operation, even if the stone is large. If the orifice is too narrow to admit this, it should at once be divided with a probe-pointed bistoury or a meatome.

1. **Introduction of the Lithotrite.**—If the size of the stone is known, the lithotrite must be adapted to it. If it be large and probably hard, a full-sized, fenestrated lithotrite should first be passed, with which the calculus may be broken into several small fragments. After this it may be withdrawn, and a smaller non-fenestrated instrument used to complete the crushing.

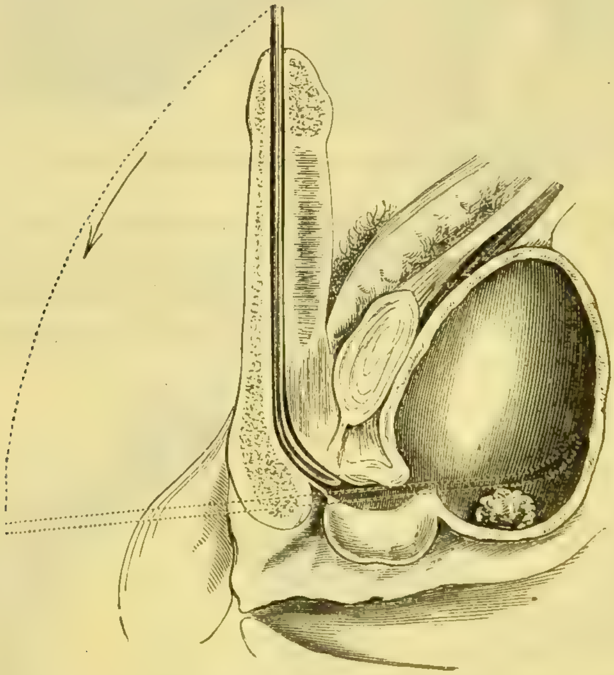


Fig. 919.—Introduction of the Lithotrite.

The operation may most conveniently be performed with the patient lying on his back either upon a hard mattress, or on a couch or table. The pelvis must be raised by a hard pillow, so as to allow the stone to roll up on the posterior surface of the bladder. The Surgeon, standing on the right side of the patient, carefully introduces the hollow sound, or catheter, and draws off the urine; he then slowly and very cautiously injects the bladder, by means of the brass syringe, with from four to six ounces of tepid water; or some antiseptic solution, such as boracic acid lotion, or Condy's fluid and water. The use of drawing off the urine is to make sure of the bladder holding the proper quantity of fluid when it is afterwards injected ; and the object in injecting it, is to distend it to such an extent as to prevent the mucous membrane from being seized in the grasp of the lithotrite, or injured by the splintering of the stone. The instrument is then withdrawn, after the situation of the stone has been detected by it, and the lithotrite is introduced. Should the patient be able to hold enough urine, viz., from three to four ounces, to protect his bladder from the action of the lithotrite or the fragments, the injection may be dispensed with, and the lithotrite may at once be used. As this is straight, with a sharp elbow near the beak, some little skill is required in passing it. In doing this the Surgeon must keep his eye upon the short curved beak of the instrument, the direction and position of which must be constantly observed or rather judged of ; and especial care must be taken, in carrying it under the pubes, not to injure the urethra by pushing the beak of the lithotrite forwards too suddenly, instead of winding it, as it were, under the arch of that bone. The instrument should first be introduced nearly parallel to the abdomen, the penis being held between the fore and middle fingers, and drawn over it. As the lithotrite passes down, it must be gradually raised to the perpendicular position ; and as its curve passes under the pubes, the handle should be depressed between the thighs (Fig. 919). The direction of the curve is the thing to bear in mind ; and the position of the handle must be varied in accordance with the course which this takes. No force must on any account be used. The weight of the handle is quite sufficient to make the instrument enter the bladder. The lithotrite should be well greased with carbolized oil, so that the blades and screw may work smoothly. Lard or vaseline should not be used for this purpose, as it is apt to clog, and to entangle gritty bits of calculus.

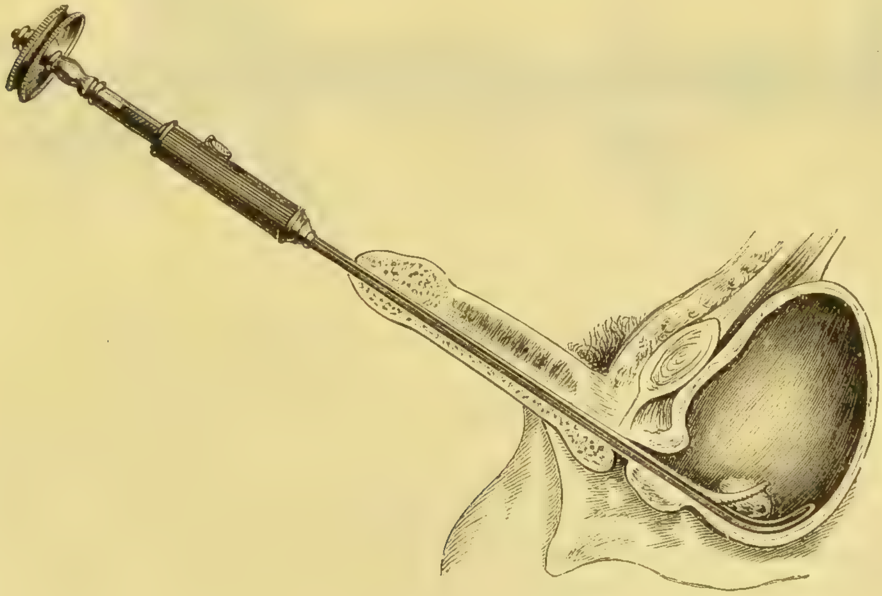


Fig. 920.—Brodie's Method of Seizing the Stone.

2. **Seizure of the Stone.**—The next point is to seize the stone, which will generally be found in the situation where its presence was detected during the sounding of the bladder. If large, the stone will probably lie low, near the neck of the bladder ; if small, it is most frequently met with at the inferior

fundus. In seizing the calculus a good deal of tact may be required. The plan recommended by Brodie should first be adopted. The closed lithotrite is pressed gently against the inferior fundus of the bladder, so as to make a conical depression in this situation. The male blade is then gently withdrawn till some slight sense of resistance is felt, indicating that it is touching the other side of the bladder. A gentle shake may then be given to the handle, and the blades closed, when, in a large proportion of cases, the stone will be found to be between them. During the whole of this proceeding the left hand, holding the instrument, must be kept perfectly steady, and no force of any kind should be used. If the stone is not at once grasped in this way, the manœuvre must be repeated, turning the blades slightly first to one side and then to the other. If this does not succeed, the plan recommended by Civiale may be tried. The closed lithotrite is used as a sound, and the situation of the stone determined. The beak of the instrument is then very gently turned towards the opposite side of the bladder, and the blades opened. The open instrument is then turned back again to the side on which the stone lies, and the blades closed. If the stone is not seized by either of these plans, it is possible that it is lying in a pouch behind the prostate. To reach it in this situation the handle of the lithotrite must be depressed between the patient's thighs, and the instrument turned round, so that the beak is directed towards the floor of the bladder. It may then be carefully opened and closed again. This manœuvre is very frequently necessary in patients above 60, in order to crush the last fragments towards the end of the operation. If the stone be round and smooth it may only be grasped after many failures ; the calculus slipping away between the blades of the instrument, and being merely scraped by them.

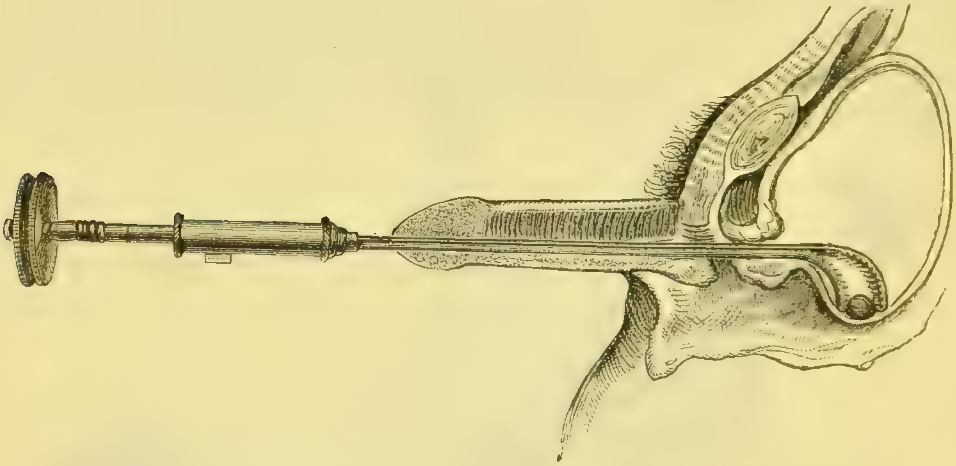


Fig. 921.—Civiale's Method of Seizing the Stone behind the Prostate.

The essential conditions during this stage of the operation are that the utmost gentleness be used in all movements of the lithotrite, that the female blade be kept as steady as possible with the left hand, while the instrument is opened and shut by moving the male blade only, which, from its lightness, can be manipulated with great delicacy, and lastly, that the operator should picture to himself with each movement of the instrument the exact position in which the blades are placed.

3. **Breaking the Stone.**—When the stone has been seized, it is held by pressing the blades together with moderate firmness, while the instrument is turned from whatever position it may be in till the beak looks forwards, and the calculus is placed about the middle of the bladder. It is highly improbable, with the instruments at present in use, that a portion of the mucous membrane of the bladder has been seized with the stone ; but should such an accident have happened, it will be detected by the sense of resistance while attempting to bring the stone to the middle of the bladder. If this were felt it would be necessary to release the stone again. If, however, the instrument moves freely in the bladder, as soon as it is in the proper position the blades must be pressed firmly together, while the sliding movement is converted into the screw movement by drawing up the button in Thompson's lithotrite or by turning the cap in Bigelow's. In both these instruments this can be done with the right hand, while the left keeps the instrument perfectly steady. If the stone be small and not too hard, the mere pressure of the hand, without using the screw, may suffice to crush it. When the screw is used it should be gradually worked by a series of short and sharp turns, so as to constitute almost percussive movements (Fig. 899). In this way the calculus is generally made to crumble down, rather than to fly asunder ; and, as it yields, the screw must be worked tightly home. The blades of the instrument may then be opened again, and a fragment of the broken calculus seized and crushed in the same way as before ; and thus the complete disintegration of the stone is gradually effected.

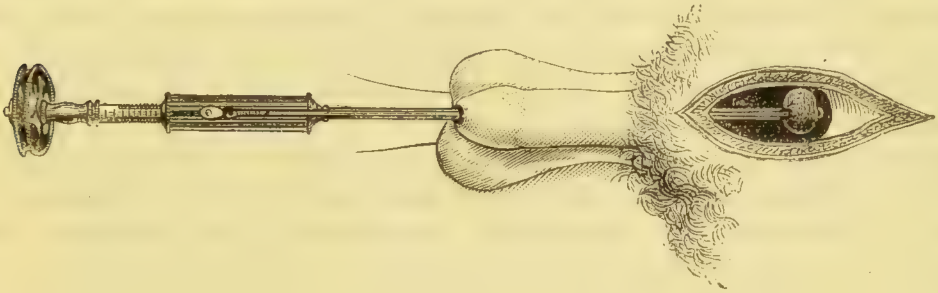


Fig. 922.—Position of Lithotrite in Crushing the Stone.

If a large fenestrated lithotrite has been used, it must be withdrawn as soon as the stone has been broken into fragments of moderate size, and the smaller non-fenestrated instrument passed to complete the crushing. This should not be removed from the bladder, if possible, till from the impossibility of catching any definite fragments it may be hoped that the whole calculus is thoroughly crushed. Repeated withdrawal and re-introduction of the lithotrite wastes time and increases the risk of bruising the urethra and prostate. Before withdrawing the lithotrite, the Surgeon must be careful to see, by the scale on the handle, that the male blade is well home. If this be not the case, and the instrument be enlarged by any fragments or detritus entangled between the blades, laceration of the neck of the bladder or urethra might occur in attempting to withdraw it. If the blades do not close perfectly, the screw must be forcibly turned, and if that fails the female blade must be held very firmly with the left hand, while the male blade is unlocked, and rapped sharply upon it two or three times, which will usually dislodge any fragments between the blades.

4. The last stage of the operation consists in **Removing the Fragments by means of the Evacuator.** For this purpose an evacuating catheter (Fig. 911, p. 1048), is passed into the bladder. This should be the largest the urethra will safely admit. This has already been determined by measurement with the urethrometer or conical sound. Bigelow generally uses No 29 French (18 English), but Sir H. Thompson states that he seldom finds it necessary to exceed No. 15 or 16 of the English scale. Bigelow prefers the straight instrument (Fig. 912), but the curved catheters usually pass more easily. Firm pressure is commonly required to pass the catheter, but no undue force must be used. It is better to use a smaller size than to run the risk of injuring the urethra by attempting to force in a larger instrument than it can safely take. The catheter having been passed, the bladder is completely emptied ; the fluid that escapes being caught in a vessel and strained through muslin to collect any fragments of the stone that it may contain. It is essential that the india-rubber bulb should be of sufficient strength ; otherwise the regurgitant stream will not be sufficiently forcible to withdraw any but the smallest fragments from the bladder. The fluid in the bottle should always contain some antiseptic ; boracic acid, or permanganate of potash, is perhaps the best. The evacuator, previously filled, having been attached to the catheter, by alternately compressing and relaxing the rubber bulb of the instrument the bladder is filled and emptied. At each injection the fragments are thrown up. At each relaxation of the bulb, some are sucked out in the rush of water. These drop into the glass receiver, where they can be seen by the Surgeon, who thus judges of the progress he is making. This process is continued until all fragments are evacuated. Should some have been left behind, too large to pass through the evacuating catheter, the lithotrite must again be introduced, and these broken up sufficiently for evacuation, which must then be resumed and continued until the bladder is emptied of all calculus. The Surgeon knows when fragments are left behind too large to pass, by their falling against the eye of the catheter, blocking it, and thus preventing the return of water into the bulb of the evacuator, as shown by its failing to expand. This may arise also from the eye of the instrument having come in contact with the wall of the bladder, or from the catheter having been accidentally withdrawn till its end lies in the prostatic urethra. Before concluding that the obstruction is due to a fragment, these two conditions must be excluded, by pushing the catheter a little further in and rotating it. A more certain sign of a fragment is a loud and distinct click every time the bulb is allowed to expand.

The removal of every fragment is the essence of Bigelow's operation. No stone must be left behind. The operation should be concluded at one sitting, however prolonged.

The **Time Occupied by the Operation** varies with the size of the stone and the ease with which the fragments are caught. Before Bigelow demonstrated the safety of prolonged operations under anæsthetics, the strictest rules were laid down as to the duration of the sitting. The first was not to exceed four minutes, and it was considered sufficient to break up the stone, leaving the fragments to be dealt with subsequently. The subsequent sittings were also limited to a few minutes. The sittings were repeated every three or four days till the whole stone was broken up, a longer or shorter interval being allowed according to the amount of irritation caused by the operation. It was only in the case of a very small stone that the operation was finished at one sitting. At the present time the crushing is completed in all but very exceptional cases at one sitting, and the results of the practice have shown that the irritation caused by a prolonged operation carefully performed is infinitely less than that set up by a mass of sharp fragments such as are left after partial crushing of a stone. If the stone is of any size an hour or an hour and an half may be occupied in completely crushing it. The longest time that Sir Henry Thompson has occupied in an operation at a single sitting has been 70 minutes. This was in the case of an unusually hard uric acid calculus weighing 2¾ ounces. In a case recorded by Surgeon-Major Keegan, of Indore, the stone weighed 3½ ounces, and was at first too large to be grasped by the lithotrite, but by gradually nibbling at it he reduced it till it could be fairly seized and crushed. The operation lasted four hours, but the patient went home well on the fourth day. In the performance of prolonged operations at a single sitting Thompson enjoins the very important caution that the patient's lower extremities should be encased in long woollen stockings, and that especial care be taken to prevent his getting chilled by exposure.

After-Treatment of Lithotrity.—After the operation a half-grain morphia suppository should be administered and the patient put to bed with a hot fomentation over the lower part of the abdomen. If the operation has for any reason been incomplete he should pass water lying on his back lest any fragments should be washed on and lodge in the urethra. When the operation is complete this precaution is not necessary. In very rare cases some retention of urine may follow owing to slight swelling of the neck of the bladder, necessitating the passage of a soft catheter. The diet should be chiefly milk and barley-water for a few days, and if any stimulant is required Hollands and barley-water is the best. The slight cystitis that usually follows the operation requires no special treatment. If there is much irritability of the bladder, henbane is often of use. If the cystitis is more severe it must be treated as described in the Chapter on Diseases of the Bladder.

Complications in Lithotrity. Size of the Stone.—Before the invention of rapid lithotrity with evacuation no stone over one inch and a half was considered suited to lithotrity. At the present time any stone that can be grasped in the blades of the lithotrite, and is not too hard to be broken, may be removed by this method. It must be remembered, however, that a large stone necessarily means a long operation, and in very old or weak patients, and especially in those suffering from chronic bronchitis and emphysema, two hours under an anæsthetic, is accompanied by considerable danger. In such cases, possibly, a better chance of life would be given by suprapubic lithotomy.

Cystitis before the Operation need not prevent its performance if the stone is small. The removal of the source of irritation, and the washing out of the foul mucus with the evacuator will often bring immediate relief. If the stone be large, and the cystitis acute, lithotomy would probably give the best chance if the condition of the patient renders some interference urgently necessary.

The **Chronic Enlargement of the Prostate** of old people was formerly one of the most serious complications of the operation of lithotrity, not so much from the difficulty it caused in the introduction of instruments as from the obstacle it offered to the expulsion of the fragments. But even before the introduction of the more perfect evacuators now in use enlarged prostate was not considered an insuperable bar to lithotrity ; as, after the stone had been crushed, the bladder could be emptied by means of the scoop, by Clover's apparatus, or by Sir P. Crampton's device, which consisted in exhausting the air from a properly-constructed bottle, fitted with a stop-cock, and then attaching this to a catheter previously introduced, and opening the stop-cock, when the pressure of the atmosphere drove the contents of the bladder, urine and grit, into the exhausted bottle. With the present evacuators moderate enlargement of the prostate can scarcely be termed an inconvenience. When the prostate is enlarged, the stone, if small, or the fragments after the first crushing, fall into a pouch behind the neck of the bladder, and it is then impossible to seize them except by reversing the blades in the manner already described (p. 1054). When the stone is seized the blades must be carefully turned into the ordinary position before it is crushed.

In cases of extreme enlargement lithotrity may be impossible, as the lithotrite may not be able to enter the bladder, or if it can be introduced its blades may be too short to reach the stone in the pouch behind the middle lobe. In such cases suprapubic lithotomy is the preferable operation.

Stricture of the Urethra, if it can be dilated to a size sufficient to admit the necessary instruments, is not a serious complication in lithotomy at a single sitting. In former times it was considered an almost insuperable obstacle to the operation from the obstruction it offered to the expulsion of the fragments.

Sacculation of the Bladder is a most serious complication, the existence of which we have unfortunately no means of determining before the operation. The fragments are very apt to fall into the sacculi, from which they are with difficulty dislodged by the evacuator. If they are left they may cause recurrence of the stone in the bladder, or give rise to encysted sacculi. If septic cystitis follows, it is possible that a fragment lodged in a sacculus might lead to ulceration and perforation.

Accidents during Lithotrity can scarcely arise except from carelessness or the use of improper force. The large instruments can scarcely make false passages, unless used with great violence ; yet I have known of a case in which the beak of the instrument was driven through the urethra into the space between the bladder and the pubes by too early and forcible depression of the handle. Nipping the coats of the bladder is almost impossible with the instruments now in use. Bending or breaking of the lithotrite can scarcely occur if the instrument has been properly tested before being used. Jamming of the instrument by a hard fragment becoming wedged in the angle between the male and female blades where they join the shaft is practically impossible with the modern instruments. If it should happen the bladder may be opened in the perinæum using the lithotrite as a staff, and the blades brought out and freed, or they may be exposed by suprapubic cystomy, and cleared or cut off with a file according to circumstances.

Accidents after the Operation.—Hæmorrhage is a rare occurrence. Should the bladder become filled with clots they may be easily removed by reintroducing the evacuating catheter and sucking them out with the evacuator, or by the introduction of a large sized gum-elastic catheter, to which an aspirator may be applied.

Impaction of Angular Fragments of Stone in the Urethra.—This most dangerous and painful accident was not uncommon in the old system of lithotrity. In modern lithotrity it can happen only if a large fragment has been accidentally left behind or if from any cause the operation has to be left incomplete. If there is any reason to believe that fragments are left in the bladder the patient must be kept in a recumbent position, as impaction most commonly arises from moving about too much or straining to pass water in an upright position. The lodgment of a fragment not only occasions great local irritation, ending perhaps in cystitis or abscess, but may give rise to severe rigors and nervous prostration. The fragments are especially apt to lodge in the prostatic urethra, or about the bulb, and there give rise to a very great degree of irritation, and even to fatal mischief.

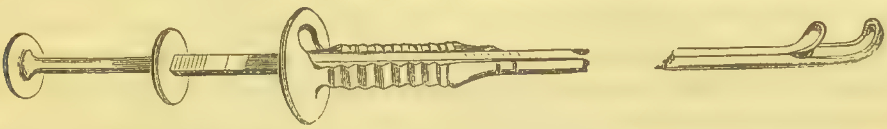


Fig. 923.—Urethral Lithotrite.

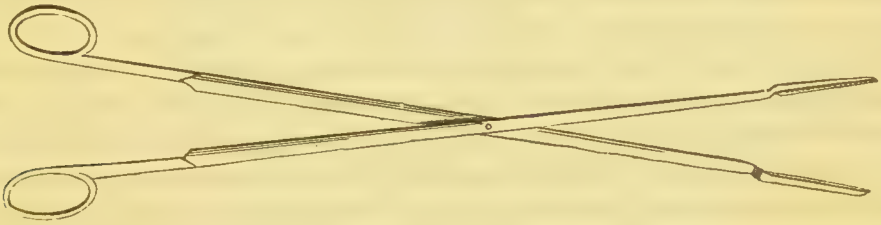


Fig. 924.—Urethral Forceps.

When the pieces are impacted low down in the urethra, it is absolutely necessary to remove them from the canal as speedily as possible, lest the constitutional disturbance occasioned by them prove fatal to the patient. This may be done in various ways. Most frequently, they may be pushed back into the bladder, by passing a large catheter carefully down to them.

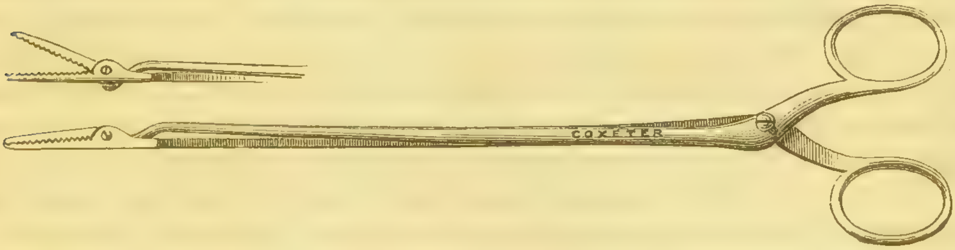


Fig. 925.—Urethral Forceps, with Alligator-jaw action. The smaller figure presents the Jaw of Forceps open.

The most convenient instrument for this purpose is one that is open-ended, so that the fragment may be received in the aperture at the end of the instrument, and so pushed on before it. Through such a catheter as this a stream of water may be injected, and the fragment thus forced back. Should these manœuvres fail, it has been proposed to crush the fragments in the urethra with a small lithotrite (Fig. 923); but this plan is somewhat hazardous, as it is very difficult to avoid pinching up the mucous membrane of the canal with the bits of stone. The safest practice seems to be, either to extract them through the urethral orifice, or to cut them out through the perinæum. Extraction through the urethral orifice may be effected by the forceps (Figs. 924, 925), or by Civiale's instrument (Fig. 334, Vol. I.). Should these means fail, or should the fragment be very deeply seated, as in the membranous portion of the urethra, and the local and constitutional irritation produced by it be so great as to threaten abscess or a fatal termination, the better plan would be to make an incision directly down upon it, and to remove it through the perinæum by a median operation of lithotomy. If such an operation as this be required, the Surgeon might feel disposed to extend the incision a little, and empty the bladder of any remaining detritus by means of a scoop.

Cystitis.—The occurrence of cystitis was formerly attributed solely to the mechanical irritation to which the bladder is subjected during the operation. The success which has attended lithotrity at a single sitting has however demonstrated beyond a doubt that the bladder is much more tolerant of mechanical irritation than was at one time believed. The effect produced directly by the operation is, in most cases, limited to slight catarrhal inflammation, with an abundant secretion of mucus and some irritability of the bladder. In the operation by numerous sittings this was frequently aggravated by the presence of large and angular fragments. The thick mucus secreted under these circumstances is never perfectly expelled, but a certain amount remains adhering to the mucous membrane of the bladder after micturition. This speedily undergoes decomposition, and the most potent cause of cystitis is the contact of this foul mixture of mucus and urine within the interior of the bladder. When decomposition sets in, the alkaline products of the decomposing urine render the mucus thick and ropy, and this still further adds to the difficulty of its complete expulsion. Under these circumstances the patient becomes poisoned by the absorption of the putrid contents of the inflamed bladder, the temperature rises, the tongue becomes brown, and if not relieved the condition will very likely terminate in death, the immediate cause of the fatal result being, in most cases, extension of the decomposition to the pelvis of the kidney and suppurative nephritis. Such a condition necessarily offers an insuperable obstacle to any further crushing operation, supposing any stone to be still present, and the only course that gives a chance of life is to perform median lithotomy, by which not only are the fragments removed but the bladder is efficiently drained of its decomposing contents. The prevention of this complication is best accomplished by the use of antiseptics. There is every reason to believe that the putrefaction of the urine is due to the introduction of an organized ferment from without. This may be carried in by the instruments or by the water used in washing out the bladder. The instruments should therefore be oiled with carbolized oil and washed in carbolic lotion before being used, and the water used to wash out the bladder should contain some antiseptic. There is, however, another way in which decomposition may reach the bladder. As before stated the mechanical irritation of the operation sets up some catarrh of the bladder and also of the urethra. The thick mucus secreted in consequence of this adheres to the mucous membrane of the urethra so that this canal, instead of being washed clean by the urine at each act of micturition, always contains a stagnant or partially stagnant layer of mucus down which decomposition may extend to the bladder. It is not sufficient therefore merely to carbolize the instruments and to use antiseptic solutions in the evacuator; the end of the penis should be constantly covered with a strip of lint soaked in glycerine and carbolic acid. In spite of all precautions, however, decomposition will often take place, and then the bladder must be washed out twice a day with an antiseptic solution. The mechanical irritation caused by so doing is of little importance when compared with the dangers of a septic accumulation in the bladder.

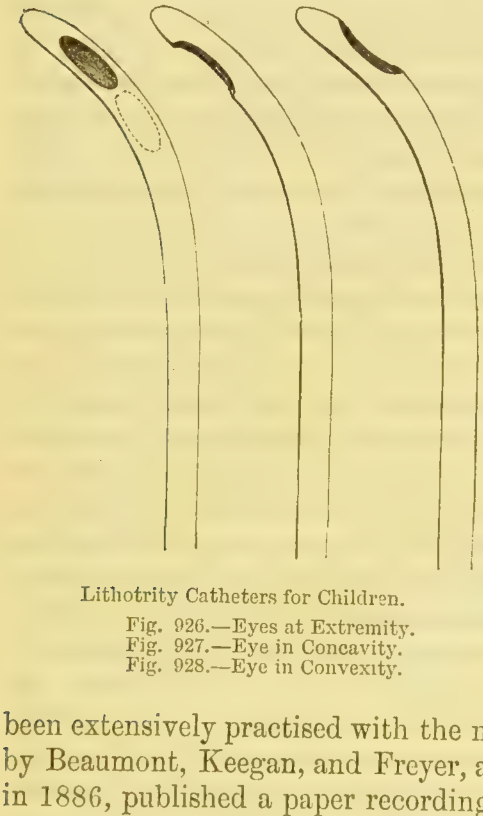
Atony of the Bladder is one of the most dangerous conditions that can occur in lithotrity. This state of things happens usually in old people, in whom the urinary organs may appear to be in a peculiarly quiet and favourable condition before the operation, the patient being able to hold his urine for six or eight hours, and to bear the injection of ten or twelve ounces of fluid. In these circumstances, the Surgeon should be upon his guard; for the danger of this condition is, that the bladder does not possess sufficient contractile power to expel its contents. These consequently accumulate in the lower fundus, and irritate the mucous membrane; and thus the foundation may be laid for fatal septic cystitis. The atony of the bladder appears to arise partly from that natural want of expulsive power which is not unfrequent in old people, and partly from a kind of paralysis of the organ, induced by the contact of the instruments, especially after long sittings.

Atony of the bladder is not so serious a complication in the operation at a single sitting, although it necessitates the careful washing out of the bladder for some time afterwards to prevent the risk of a septic accumulation. In the operation by repeated sittings atony was much more serious, and it was essential that the Surgeon should rid the patient of the fragments he could not expel by washing out the bladder; but it was usually safer to get the patient in as good a condition as possible, and then cut him by the median operation. This I once did in an interesting case under my care at the Hospital; the patient, an old man, had been lithotrized by a Surgeon out of doors a few weeks before admission, but no fragments had passed; on sounding him, I found a moderate-sized calculus, with what appeared to be a large mass of soft concretion, of the nature of which I was not aware until after its removal; the patient having concealed the fact of his having been lithotrized. On cutting him in the usual way, I removed a lithic acid calculus about as large as a pigeon's egg, and a handful of fragments of another calculus of the same composition, which had been crusted over and stuck together by phosphatic deposit. The patient made a very good recovery.

Disease of the Kidneys is in Lithotrity, as in all other operations on the urinary organs, the most common cause of danger and of death. The various forms of fatal kidney-disease have been so fully described in Chapter LXVI. that I must refer the reader to it.

Pyæmia and Septicæmia are occasional but uncommon causes of death.

Constitutional Disturbance.—Very considerable constitutional disturbance occasionally follows lithotrity. The patient is seized with severe and long-continued rigors, followed by profuse sweating, lasting for many hours. These serious symptoms were formerly most apt to come on after the first sitting; but the experience of Bigelow's method has shown that they are not more prone to occur after a prolonged operation than after the short sittings formerly adopted. They may pass off quickly, as in the analogous conditions to those that are apt to follow the introduction of instruments in strictures, &c., or they may persist and assume the character already described as indicating septicæmia or renal inflammation. These serious consequences are especially apt to happen when there is previous disease of the kidneys. Indeed, there is no condition that is more directly antagonistic to the success of lithotrity than interstitial nephritis. When this is present to any considerable extent, with or without much albumen in the urine, casts of tubes and blood, the increased irritation induced by the operation will almost to a certainty prove fatal. In other instances, again, the fatal result is more directly dependent on the irritation induced by the operation leading to the formation of abscesses in the neighbourhood of the prostate, or around the neck of the bladder; and in other instances, again, on the supervention of unhealthy suppuration in some of the sacculi that are occasionally met with in this organ. The *Treatment* of this state of things should consist in the free administration of stimulants—brandy, ammonia, and ether—followed by a full dose of opium, and abundant warm diluents. If the bladder contains foul urine this must be removed by washing out with antiseptic solutions. Especial care must be taken in those cases in which any stone remains not to repeat the sitting for at least a week or ten days after the rigors have passed off.



Lithotrity Catheters for Children.

Fig. 926.—Eyes at Extremity.
Fig. 927.—Eye in Concavity.
Fig. 928.—Eye in Convexity.

Lithotrity in Boys.—Until Bigelow introduced his method, although lithotrity had been occasionally performed on boys, it was not considered a satisfactory or advisable proceeding, partly because of the small size and delicate structure of the child's urethra, and partly because of the difficulty of expelling the fragments. During the last few years, however, it has been extensively practised with the most satisfactory results, especially in India, by Beaumont, Keegan, and Freyer, and in this country by Walsham. Keegan, in 1886, published a paper recording 58 cases of lithotrity in boys, only 7 of whom were over ten years of age, with only 1 death, in a child aged four years. The stone had formed round a foreign body which had entered the bladder from the rectum, and, if its nature had been known, the child would have been cut. The largest stone removed weighed 344 grains, and the child was only 3 days in hospital. Keegan clearly showed by his observations that the urethra of a male child is much more capacious than is generally supposed. The smallest lithotrite used in any case was No. 7, but in the great majority of children over three years of age, No. 8 could be passed with ease. The evacuating catheter used was usually No. 8 or No. 9. The details of the operation are the same as in the adult, only, if possible, still greater gentleness of manipulation is required. The urethra should be measured before selecting the instruments, either by a urethrometer or a conical bougie. If necessary, the meatus must be enlarged. Keegan lays it down as a rule that no instrument must be used which will not pass freely in and out of the bladder, and he states that he has met with cases in which no lithotrite could be safely used, and cutting became necessary. Whether lithotrity will replace the cutting operations in children as it has in the adult remains to be seen. The low death-rate obtained by Surgeon-Major Keegan with the former operation, has been equalled with the latter by Surgeon-Major Keelan, who has cut 78 children under ten by the lateral method without a death. Further experience alone can show which is the preferable proceeding.

PERINÆAL LITHOTRITY.—After a stone had been broken up but not completely removed at one sitting, it occasionally happened that the fragments became a source of so much irritation that the crushing operation had to be abandoned, and lithotomy was required, in order to relieve the patient. Again, during the operation of lithotomy, the operator may meet with so large a stone, that he cannot extract it with safety, and he then breaks it up in order to remove it in a fragmentary manner, or the stone may be so soft that it crumbles under the pressure of the forceps. These circumstances, familiar to all lithotomists, have led various Surgeons to recommend, as a formal operation, the breaking up of calculi before extraction, in order that the removal of the broken stone might be effected through a smaller incision than would be required for its extraction if entire. Without going back to the records of ancient or even mediæval surgery for illustrations of this operation, it suffices to say that in modern times such a procedure has been advocated by many distinguished Surgeons, more especially by Malgaigne, under the term of "Lithotriptic Lithotomy."

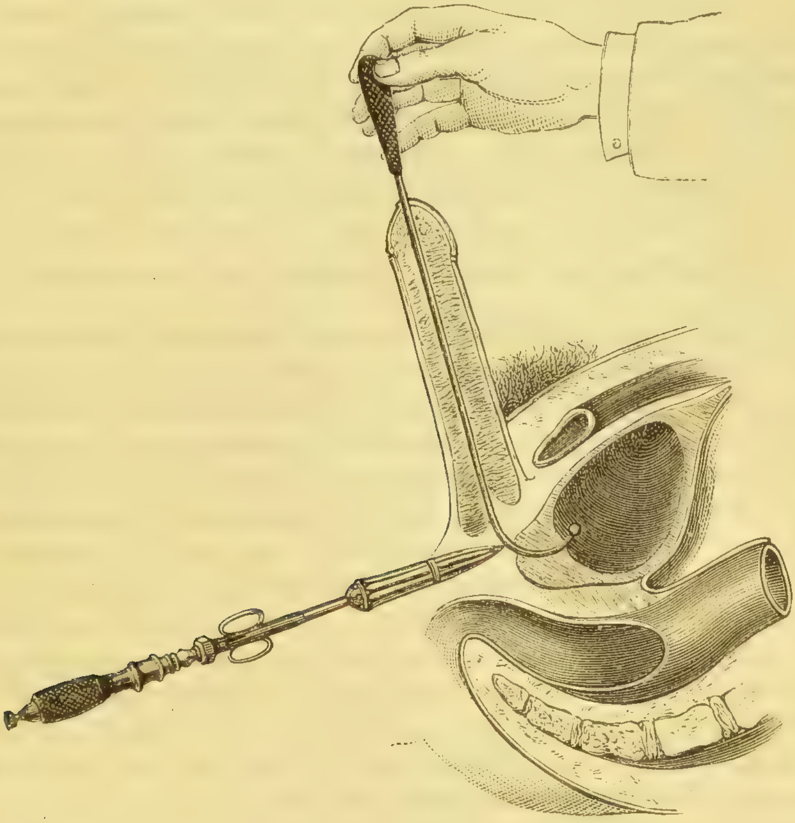


Fig. 929.—Perinæal Lithotrity. Introduction of Dilator (Dolbeau).

Dolbeau has reduced to a formal operation, which he has described as "*Perinæal Lithotrity*," those procedures which were formerly undertaken without any very definite rules.

The operation is of four stages: 1. The making of an incision in the median line into the membranous portion of the urethra on a grooved staff; 2. The slow and gradual dilatation of the neck of the bladder by means of a six-bladed "dilator;" 3. The introduction through the dilated neck of the bladder of the "lithoclast," a powerful forceps for seizing and breaking up the stone; and the extraction of the fragments and pulverized stone by means of small forceps and the scoop.

Results.—The results of perinæal lithotrity do not appear hitherto to have been satisfactory. In 30 operations there were 5 deaths, which, considering that at least four of the patients were under twenty years of age, is fully as high as, if not higher than, what occurs in lateral lithotomy, and far exceeds that resulting from lithotrity. In fact there is nothing to justify the performance of such an operation. If the case is for any reason not suited to lithotrity and the stone is too large to be easily extracted whole by the perinæum, the high operation is the proper treatment to adopt.

COMPARISON BETWEEN LITHOTOMY AND LITHOTRITY.

Lithotomy and lithotrity differ so entirely from one another in principle and detail, that it is useless to attempt to establish a comparison between the different steps of these two operations. It is, however, a question of the very first importance and interest to ascertain by which operation a patient can most safely have a calculus removed from his bladder. In determining this point, it is necessary not only to make a comparison between the general results of cases that have been subjected to the two procedures, but more especially to ascertain those circumstances that influence the result of each operation in particular cases—to determine, in fact, in what cases lithotomy, and in what lithotrity, holds out the best prospect to the patient. Both operations have been reduced to great simplicity and certainty; but neither can be exclusively practised. It is undoubtedly the duty of the Surgeon to make himself familiar with the practice of both, and to adopt that which promises best in the particular instance with which he has to do. In all cases in which it is practicable, and in all cases even in which the chances of the two operations are evenly balanced, lithotrity should as a matter of humanity be preferred to lithotomy. Probably about nine-tenths of all cases of stone occurring in the adult are proper for lithotrity, and the proportion would be even greater if patients always applied early for relief, or if, instead of being subjected to medical treatment, they were at once put under proper Surgical care, and the stone detected.

Statistics.—The statistics cannot represent the true state of the question so far as a general comparison between the operations is concerned. For it must be borne in mind that those cases that are lithotrized have invariably been picked; whilst lithotomy has been performed on almost all patients indiscriminately as they have presented themselves. For lithotrity to be successfully done, it is necessary that the stone be of moderate size, and that the urinary organs be in a healthy state and free from irritation; and this is the state in which most of the cases have been, in which crushing has been done.

In lithotomy cases, on the other hand, the Surgeon has had to contend with all the difficulties of large or multiple calculi, diseased bladders, and bad constitutions. Hence, in comparing the statistics of the results of lithotrity with those of lithotomy, we compare the statistics of the results of operations performed under the most favourable circumstances on a series of selected cases, with those of cases taken indiscriminately and often presenting most unfavourable conditions.

As Sir Henry Thompson pointed out in his admirable course of Lectures, delivered at the Royal College of Surgeons, the only method by which we can ascertain the effect of lithotrity in reducing the mortality from stone in the bladder, is to contrast the results obtained, when lithotomy was the sole operation practised, with those of the present day, when lithotrity has become the rule and the cutting operation the exception. For this purpose he contrasts the statistics of three periods; first, when lithotomy only was performed; secondly, the transitional period from 1835 to between 1860 and 1870, when about an equal number of cases were submitted to each operation; and lastly, the modern period, when lithotomy has been the exception. For the first period he selects the statistics of the Norwich Hospital from 1770 to 1830, as published by Crosse. During that time 704 patients of all ages were operated on for stone; of these, 35 were females, of whom 2 died: 243 were males under 20, of whom 27, or 8 per cent., died. The remaining 326 were adult males, and of these 64 died, or 20 per cent. Of the adult males, 75 were over 60, and of these 22, or 29·3 per cent., died. These correspond very closely to the larger statistics collected by Thompson, including 1827 lithotomies. Of these 1028 were on patients from 1 year of age to 16 inclusive; of these 68 died, or 6·6 per cent.; 528 between 17 and 58, with 86 deaths, or 16 per cent.; and 271 between 59 and 81, with 75 deaths, or 27·7 per cent.

For the second period Thompson gives the statistics of Keith, of Aberdeen, and Sir William Fergusson. Keith operated upon 304 cases of all ages; 4 were females, none of whom died; 23 were children; 19 were submitted to lithotomy, and 4 to lithotrity, with 1 death. The remaining 277 were male adults; of these 161 were cut, with 38 deaths, or 24 per cent.; 116 were submitted to lithotrity, with 7 deaths, or 6 per cent. The total death-rate amongst male adults was, therefore, 1 in 6½, or 15 per cent. Fergusson's cases amounted to 271, including 52 children, all cut, with 2 deaths, or 4 per cent. The remaining 219 were male adults; of these 110 were cut, with 33 deaths, or 30 per cent.; and 109 crushed, with 12 deaths, or 11 per cent.; the combined death-rate for the 219 cases being 20 per cent.

For the third period Sir Henry Thompson gives his own results, although possibly the earlier cases might be more properly included in the intermediate period. The proportion of lithotomies in his practice has steadily diminished. Of his first 200 cases, 48 were cut; while since 1878, of 211 cases, he has cut only 15; and, of the last 125, only 4 were submitted to lithotomy. Sir Henry Thompson's cases, being derived chiefly from private practice, show but a small proportion of children, 15 in all, of whom 12 were cut, with 1 death, and 3 successfully crushed; 13 were females, of whom 10 were cut, with 1 death, and in 3 lithotrity was performed. Excluding these, there remain 782 adult males. Of these 110 were cut, with 39 deaths, or 35 per cent.; 672 were treated by lithotrity, with 43 deaths, or 6·5 per cent., or 1 in 15½;

making a total of 782 cases, with 82 deaths, 1 in 9½, or 10½ per cent. No less than 595 of these patients were over 50 years of age. The number of individuals upon whom these operations were performed was 716 ; 61 cases being operated on a second time, 9 a third, 3 four times, and 2 five times. Cases of small secondary phosphatic accumulations were not included as operations. During the last five years Sir Henry Thompson has uniformly adopted the operation by the single sitting, and the results have been most satisfactory. Of 121 cases treated by this method, only 4 died, 1 in 30, or 3·3 per cent.

The general result of these figures is to show that when lithotomy was the sole mode of treatment, about 1 in 5 of all adult males operated on died. During the transition period the death-rate was about 1 in 6 ; since lithotrity has been more extensively adopted, it has fallen to about 1 in 9½, and this has still further been reduced by the adoption of the operation at one sitting.

The mortality from lithotrity in hospital practice has usually been higher than in private. This difference between the results of this operation in hospital and in private practice can easily be accounted for by the difference in the constitutions of the patients, and by their applying for relief in private in a less advanced form of the disease than in hospital practice. We find that the same holds good with regard to the results of lithotomy. Thus, Coulson states that Dudley lost only 1 in 36 of the *private* patients that he cut; Mettauer, 1 in 36½ ; Martineau, 1 in 42 ; and Mott, 1 in 50. These results, which are fully as favourable as the best statistics of lithotrity, must, however, be regarded as exceptional; but they suffice to show the influence which the constitution of the patient, and a proper selection of cases, may exercise upon the results of the cutting operation.

Lithotrity, as has already been stated, cannot be applied to all cases of stone; in most that are unsuited to this operation, lithotomy may be done with success. In some cases, however, no operation can be practised, in consequence of serious disease of the genitals, bladder, or kidneys, or of some visceral mischief that would necessarily interfere with the performance of any capital operation. The necessity of *selecting* cases of lithotrity is as great as ever, although the field of the operation has been greatly enlarged by the modern improvements in its performance.

Selection of Operation: Lithotomy or Lithotrity.—The circumstances that must chiefly determine the Surgeon in the selection of the operation to be performed are—1. The Age of the Patient ; 2. The Size and Character of the Stone ; and 3. The Condition of the Urinary Organs.

1. **Age.**—In adults of all ages the general rule is to prefer the crushing operation whenever other conditions make it practicable. In old men it is very important to crush, if possible, as lithotomy in advanced life is extremely fatal. Lithotrity in the hands of many Surgeons has been attended with great success in old age. Thus, Segalas states that, of 14 octogenarians whom he lithotrized, he did not lose one ; and of 27 septuagenarians, but two.

In children under puberty lithotomy was, until recently, the only recognised operation and was attended with great success. Thus, of 35 children under 10, operated on by Cheselden, only 1 died ; of 58 children cut for stone at St. Thomas's, but 1 case proved fatal ; and the average mortality of lithotomy cases in children is not more than about 1 in 14. Lithotrity was on the other hand by no means successful. Guersant at the Children's

Hospital in Paris, performed lithotrity in children 40 times—35 of the cases being in boys: of these, 7 died, and 3 at least of the others required to be afterwards subjected to lithotomy. Of the deaths, 4 were caused by croup and scarlatina, and 3 were attributable to the operation. These results are anything but satisfactory when compared with those of lithotomy in children in this country, or even in Guersant's own practice; for, of 100 that he cut, 14 died. The results obtained by Keegan, Walsham and others by the adoption of Bigelow's method have been such as to make a reconsideration of the question necessary. They have shown that the operation is not only practicable, but safe, but further evidence is required to show that it is safer as a general mode of treatment than lithotomy. The question must at the present time be considered an open one.

2. **Size and Character of the Stone.**—With regard to the size of the stone, there is no doubt that a small stone is more favourable for lithotrity than a large one. All calculi below one inch in diameter may easily be crushed provided no special circumstance is present rendering the operation undesirable. In regard to larger stones, it is difficult at the present day to lay down any hard and fast line. Until recently, it was not considered advisable to attempt to crush a stone that was above one inch and a half in diameter; but since the introduction of Bigelow's method, stones considerably above this size have often been successfully removed. Much will depend on the composition and density of the calculus. The chief objection to lithotrity in large stones was not so much that the stone could not be broken, because unless it was too large to get into the blades of the lithotrite this could usually be done; but that the mass of fragments to come away by the urethra, and the repeated operations required for their removal usually produced a dangerous amount of irritation. The use of evacuators has overcome these objections for stones of two inches in diameter; but we are not in a position as yet to say what is the maximum size that can be safely attacked. The different forms of stone vary in the ease with which they are broken up. Uric acid calculi, giving a clear ringing sound, do not disintegrate readily, but split up into sharp and angular spicula and scales. *Oxalate of lime* calculi, occurring chiefly in young people, break up very readily; and, as there is usually a co-existing healthy state of the urinary organs, the cases have a favourable issue. *Phosphatic calculi*, which are soft and friable, and do not yield angular fragments requiring repeated disintegration, may, even if of larger size than that mentioned, be broken up. At the same time the patient may often derive great benefit from the thorough washing out of the bladder with the evacuator, as these concretions are commonly the result of chronic cystitis, with alkaline decomposition of the urine. But the shattered state of system, and the irritable condition of the urinary organs accompanying phosphatic calculi, often counterbalance the advantage that would otherwise have been derived from the character of the stone.

The presence of *several stones* does not add materially to the difficulties of lithotrity. If, however, the numbers are very large and the size small, it would be perhaps safer to remove them by median lithotomy than by a prolonged crushing operation which might take one or two hours. Thus, in one case I removed 50 small calculi, varying from a quarter to half an inch in diameter, by a median incision. Occasionally multiple calculi are very small, so that they can mostly be washed out uncrushed through the evacuator; from 50 to 100 separate stones may be thus removed. Sometimes a calculus, after having been broken up into several fragments, has been left in the bladder, each fragment forming the nucleus for a new stone. Such cases are usually most successfully cut ; but in favourable circumstances as to the condition of the urinary organs, they may be subjected to lithotrity.

The rule may, therefore, at the present time, be summarised thus :—any stone which can be grasped by the lithotrite and broken, may be removed by lithotrity provided other conditions are favourable.

3. **The Conditions of the Urinary Organs** that influence the propriety of performing lithotrity or lithotomy have reference to the state of the *kidneys*, the *bladder*, the *urethra*, and the *prostate*.

The question of the advisability of lithotrity was, before Bigelow's improvements in the operation, much influenced by the degree of irritability of the bladder and urethra, and the ease with which the patient bore the introduction of instruments, but these points have little influence now that the operation is done at one sitting under an anæsthetic. In fact an irritable patient would suffer far less from lithotrity than from lithotomy.

Cystitis, if moderate in degree, is no bar to lithotrity as at present performed unless the stone be very large ; in fact the removal of the calculus and the thorough cleaning of the bladder by the evacuator frequently leads to rapid improvement. If, however, the stone is large, the cystitis severe, the irritability of the bladder great, and more especially if the patient be old and the inflammation has not yielded to the ordinary treatment, lithotomy will probably be the safer proceeding. Great hypertrophy of the bladder with fasciculation and sacculation are disadvantageous for lithotomy owing to the difficulty of completely removing the fragments with the evacuator. Still by thorough washing and by repeating it, perhaps in a few days, the difficulties may be overcome. The difficulties in lithotrity from atony of the bladder have been already described (p. 1061). At the present time atony of the bladder is no objection to lithotrity. Stricture of the urethra under ordinary circumstances offers no great obstruction to lithotrity (p. 1058). In fact, if a staff can be passed on which lithotomy could be safely performed, the stricture can easily be stretched up to the point necessary to admit the lithotrite and the evacuating catheters. Enlargement of the prostate, unless very excessive, offers but little difficulty in lithotrity (p. 1057). Acute inflammatory disease, or abscess of the prostate, necessarily prevents the performance of lithotrity.

In encysted calculus lithotrity is obviously impossible.

The condition of the *kidneys* merits special attention. If these organs be diseased, as indicated by the presence of casts of tubes, or of a considerable quantity of albumen in the urine, or in any other way, the performance of a prolonged operation in the bladder would be likely materially to increase the mischief in them, and consequently ought not to be undertaken. Organic disease of the kidneys is a more serious obstacle to lithotrity than to lithotomy, on account of the prolonged nature of the operation, and the greater liability to sympathetic or propagated irritation in these organs. It is not only to lithotrity, however, that renal disease is unfavourable ; it is also a cause of danger in lithotomy in consequence of the tendency to diffuse inflammation of the bladder, prostate, and surrounding areolar planes, and to pyæmia, that always co-exists with kidney disease.

Diabetes is not commonly associated with calculus. I have, indeed, but very rarely seen the two conditions combined. The only form of calculus that I have seen in diabetic patients has been the uric acid. It is necessarily very hazardous to operate in such cases, at least by lithotomy. And even if lithotrity be determined on, it would be well to defer the operation until the glycosuria has been checked or removed, at least for a time, by proper treatment.

I have said nothing in this comparison between cutting and crushing of the comparative painfulness of the two operations, as both are in the present day done during anæsthesia. The suffering during the after-treatment, when all goes well, is about equal, while the discomfort is infinitely less in lithotrity.

To sum up, therefore, the rules of practice may be given as follows :—

In all ordinary cases in the adult lithotrity by Bigelow's method at a single sitting should be the rule of practice for stones up to two inches, provided they are not too hard to be crushed by the lithotrite.

When the stone is two inches in diameter lithotomy is usually preferable.

Extreme enlargement of the prostate, encysted calculus, a large stone with severe cystitis and grave suspicions of kidney disease, render crushing inadvisable. In *children* lithotrity, especially for very small stones, seems the proper practice ; but the evidence is not yet sufficient to justify the recommendation of crushing in all possible cases, as in the adult.

Choice of Operation in Lithotomy.—The particular operation to which recourse should be had when cutting is decided on will also vary according to circumstances. In the adult, if the stone be small, and for any reason lithotrity is impracticable, the *median* may be performed. If it be of moderate size the general rule followed up to the present time has been to perform the *lateral*, especially in children. The advocates of the suprapubic cannot as yet be said to have proved its superiority to the lateral in all cases, but there is sufficient evidence of its safety to justify its performance should the Surgeon prefer it. In all very large stones the *suprapubic* is the proper operation to adopt. The medio-bilateral and recto-vesical have been abandoned.

The Result of Operations for Stone will depend in a great measure upon the condition of the bladder, and the character of the stone. If the bladder be healthy, all symptoms will cease on the removal of the calculus, and the patient will be restored to perfect health. This usually happens when the calculus is of the lithic acid or the oxalate of lime variety, and of renal origin. If, however, the bladder be unsound, irritable, and the urine alkaline from decomposition, and disposed to the deposit of phosphatic matters, the calculus being phosphatic, and chiefly, if not wholly, vesical in its origin, then an irritable state of bladder may be left, or may speedily return after the operation, which will consequently have been productive of little, or only of temporary benefit.

Recurrence of Calculus after Operation.—This may take place from four distinct causes :—1, in consequence of a continuance of the constitutional condition, under the influence of which the calculus was originally formed : 2, from the descent of a renal calculus, which has existed in the kidney before the first operation ; 3, from a fragment of calculus having been accidentally left in the bladder ; and 4, from the accumulation of phosphatic deposit in the fundus of the bladder, or in the line of imperfectly healed incisions.

Relapse from the first cause is probably not very common. When it occurs, the recurrent calculus is of course of the same composition as the primary one. The occasional occurrence of relapse shows the necessity of continuing constitutional treatment adapted to the particular diathesis, after the removal of the calculus from the bladder.

Recurrence of calculus from the descent of a new stone from the kidney every now and then occurs, and is especially liable to be met with in those cases in which the primary calculi are multiple and small. In these cases, the relapse may take place very shortly after the first operation, and will be preceded by the usual symptoms of the descent of a stone from the kidney.

Relapse from the retention of a fragment which serves as the nucleus of another stone, will undoubtedly occasionally occur, although its occurrence is fairly attributable to want of due care on the part of the Surgeon. It is apt to happen more frequently after lithotrity than after lithotomy, and it is probably to this cause chiefly that we must refer the greater liability to relapse after the crushing than the cutting operation. But it may happen after lithotomy, that a fragment is left behind when the stone has been broken during extraction, and the bladder not thoroughly washed out. But even in this case, the bit of stone will usually be carried out of the wound by the flow of urine through it.

Recurrence from the formation of a phosphatic calculus in the bladder, as the result of chronic cystitis with decomposition of the urine, may occur occasionally after lithotomy, but is much more common after lithotrity. In these cases a lithotrite must be passed, and the soft mass crushed up and washed out with a catheter and evacuator. The patient must be taught to wash his own bladder out regularly every day with a dilute acid solution, to which some quinine may be added. Some years ago I had under my care a patient eighty years of age, on whom I performed lithotrity for a uric acid calculus. During the next five years I removed large phosphatic concretions on more than a dozen occasions. At last the tendency to recurrence ceased, and for three years before his death no new formation took place. On some occasions the mass measured over an inch and a half in diameter, yet under anæsthetics it was broken up and washed out with Bigelow's apparatus without the slightest irritation, the patient usually returning to the country on the second day after the operation.

Phosphatic deposit may take place also in the track of a partially healed lithotomy wound, forming a crust on its surface. I have known such a deposit to form in the perinæum, when the wound had degenerated into a sinus.

According to C. Williams, the relapses in the Norwich Hospital are 27 in 1015 operations, or 1 in 36, or in 935 lithotomies 1 in 33. Lithotomy was performed a second time on 24 patients; a third time on 3; and a fourth time on 1. Twenty-three were cured, 5 died. All the patients were males. The registers of the Louisville Hospital give 1 relapse in 116 cases of lithotomy; and according to Civiale the return of calculus after lithotomy was in Bavaria 1 in 32, in Bohemia 1 in 46, in Dalmatia 1 in 43, and in France 1 in 74.

After lithotrity, relapse is more common; although it is probably less frequent now than formerly, and will become less frequent as the details of the operation come to be better understood, and more carefully practised. In the practice of Civiale it occurred about once in every tenth case. But this estimate, high as it is, falls below what happened formerly in surgical practice. Civiale stated that, of 36 private patients on whom he operated in 1860, 10 had previously been operated on, the stone having reformed. This must evidently have arisen from some fragment of calculus having escaped detection and having been left behind, thus constituting a nucleus for a fresh formation. The frequency of the occurrence of secondary calculi after lithotrity has greatly diminished since the time of Civiale, and can no longer constitute an objection to that operation. It still occurs, however, often enough to show the necessity of the Surgeon most carefully examining the bladder before he pronounces the patient cured; and even then watching him for some length of time, in order to meet a recurrent calculus at its first formation, and to adopt means for its early removal. Lithotrity cannot therefore be said to be so complete a cure in all cases as lithotomy. Not only is recurrence of calculus more common after the former than after the latter operation, but it not uncommonly happens that patients who have been lithotrized successfully, and in whom no recurrent calculus has formed, continue to suffer for a great length of time afterwards from very distressing irritability of the bladder, which resists in the most obstinate manner all the ordinary methods of treatment. This is not the case after lithotomy; when a patient once recovers his bladder usually regains its tone completely, and no trace of evil consequences is left.

Treatment.—In the event of a secondary calculus forming, whether after lithotomy or lithotrity, either method may again be employed, according to the nature of the case. Most generally, the bladder may be cleared of the recurrent calculus by means of the lithotrite. If lithotomy have previously been performed, and it be thought proper again to have recourse to it, this may be done again in the usual way, through the cicatrix left by the former wound; or the Surgeon, if ambidextrous, may adopt Liston's advice to cut through the right side of the perinæum on a staff with a groove to the left of its convexity. As this procedure, however, would entail the use of the left hand for cutting and extracting, most Surgeons would prefer either the operation through the site of the old wound, or, better still, the median operation. Whatever procedure, however, may be adopted, it should be borne in mind that the rectum may have become rather firmly adherent to the membranous portion of the urethra and the apex of the prostate, in consequence of the contraction of the old cicatrix, and may thus be endangered.

URETHRAL CALCULUS.

Calculi are not unfrequently found impacted in the urethra, especially in children. They are most commonly formed in the kidney, whence they pass into the bladder, and thence into the urethra, through which they usually escape; but in some instances they lodge in the latter channel, more especially at the bulb or in the navicular fossa. These calculi are commonly of the uric acid or oxalate of lime varieties; they are generally round, but not uncommonly elongated or spindle-shaped.

Although most urethral calculi are undoubtedly renal in their origin, there can be little doubt that in some more rare cases they may be primarily formed in the canal. They will then be found to be phosphatic, usually consequent upon stricture, and perhaps of large size. In some cases these concretions are moulded in the prostatic and bulbous portions of the urethra, being elongated, rounded at one end, and pointed at the other. In other instances, again, they appear to be formed in a pouch that lies to the outside of the urethra, and that is connected with it only by a small aperture. I have removed a stone of this kind composed of triple phosphate, weighing an ounce, and about the size of a walnut, smooth and rounded, from a point lying between the upper wall of the urethra and the symphysis pubis, in a clergyman who had for many years suffered from very tight stricture. One of the most remarkable instances of this kind is represented in the annexed cut (Fig. 930), taken from a drawing in Sir R. Carswell's collection at University College. The stone here was of very large size—equal in bulk to two horse-chestnuts.

Symptoms.—In the adult, the presence of a calculus in the urethra may be suspected by the difficulty that is occasioned in micturition, and ascertained by the possibility of feeling the stone through the walls of the canal, or of detecting it by introducing a sound into the urethra. In boys, impaction of calculus in the urethra is almost the sole cause of retention of urine. When called, therefore, to a child suffering from this condition, we should always at once suspect calculus as being the cause, and examine the urethra from the perinæum or rectum, and by the introduction of a sound.

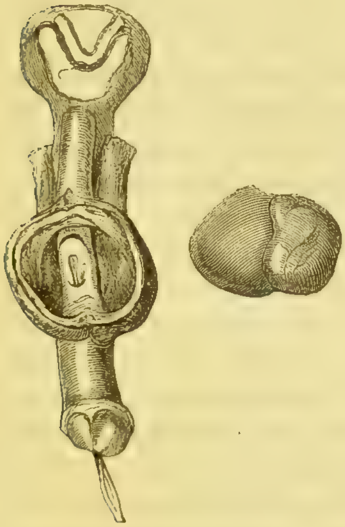


Fig. 930.—Extra-urethral Calculus.

Treatment.—The treatment of urethral calculus will vary in the adult and in the child. *In the Adult*, urethral calculi may be removed by extraction, lithotrity, or incision. When situated towards the anterior part of the canal, a urethral calculus may frequently be extracted by working it forwards between the finger and thumb, the patient being under chloroform. Should this plan not succeed, it may be removed by passing a long and very narrow-bladed pair of forceps down to it, by which it is seized and drawn forwards; occasionally, when it has reached the navicular fossa, it will not pass through the urethral orifice unless this be enlarged by incision with a probe-pointed bistoury. If the calculus cannot be extracted in this way, it should, if possible, be pushed back into the bladder and removed by lithotrity. If, however, it appear to be firmly fixed, an incision must be made down upon it, through the urethra, by which it may be removed. It is a good rule not to make this incision in any part of the urethra anterior to the scrotum if it is possible to avoid it; for, in consequence of the coverings of the penile portion of the urethra being very thin, the aperture will probably not close, but a fistulous opening will be left. When the stone is situated in the scrotal portion of the urethra, there would be some risk of abscess and of urinary infiltration if the incision were made through the lax tissues of the scrotum. Hence, if as sometimes happens, the stone may be pushed back to the bulb or membranous urethra, but not into the bladder without using a dangerous amount of force, it is better to cut down upon it, and extract it through the perinæum by an incision in the mesial line. This operation may readily be done by passing a staff, grooved along its convexity, or an ordinary director, as far as the calculus, and making an incision upon the end of it, so as to lay open the urethra; the staff is then removed, and the calculus extracted by means of a slender pair of forceps. A catheter should next be passed into the bladder, and retained there for a few days, in order to lessen the tendency to the formation of urinary fistula.

It may happen that the calculus, impacted in the urethra, is only one of several ; others being lodged in the bladder. In order to ascertain this, the Surgeon should, after removing the calculus for which the operation has been performed, pass a sound into the bladder, so as to ascertain whether any other concretions exist in that organ ; and if so, they should at once be removed by the median operation of lithotomy, the incision of the membranous portion of the urethra being extended backwards to the prostate. I once saw Liston extract two vesical calculi, after having removed one that had blocked up the urethra, by converting the perineal incision into that of lateral lithotomy.

Impaction of a Calculus in the Urethra of a Boy may lead to very serious consequences. In the majority of instances it occasions more or less complete retention of urine, which requires relief. This may be given in one of two ways. 1. If the stone be near the urethral orifice, it may be extracted ; and, 2, if situated more deeply, it may be pushed back to the perinæum—there fixed by the finger, and cut down upon in the mesial line. It should not be pushed back into the bladder unless the Surgeon is prepared to crush it ; and as in children this operation requires special instruments, it can only be exceptionally that such a line of treatment would be justifiable.

If the stone is allowed to continue fixed in the urethra very serious consequences may ensue. If it completely obstructs the canal, the membranous part of the urethra may give way during the violent efforts at micturition, and extravasation of urine will take place. In other cases, if it be irregular in shape, a small quantity of water may pass. Under these circumstances there is intense irritability of the bladder, the urine passing with much pain every few minutes, or constant dribbling may set in. The distended bladder can be recognized above the pubes. Some purulent discharge will be observed about the meatus, and there will be some hard ill-defined swelling in the perinæum, with much tenderness in this region. The presence of the stone may at last cause ulceration of the urethra with the formation of urinary abscess in the perinæum, followed perhaps by extravasation of urine into the scrotum and its diffusion beneath the superficial fascia in the usual direction, with the ordinary disastrous results of inflammation and sloughing. On passing a sound, no stone probably will be found, as this has escaped from the urethra, and is lying in a pouch in some part of the perinæum, and in the midst of broken-down areolar tissue and pus ; into this cavity the sound will readily pass.

The *Treatment* in these cases is simple. It consists in introducing a grooved staff, placing the boy in the lithotomy position, and then freely incising the mesial line of the perinæum, so as to open up the urinary abscess ; in this the stone may be found, or it may be so enveloped in the sloughy tissues as to escape detection ; perhaps it will escape through the wound in a few days, and be found lying on the bed. Should there be much hæmorrhage a catheter may be tied in and the wound plugged with salicylic or iodoform-wool secured by a T-bandage. If extravasation of urine have occurred, free incisions must be made in the usual way, and the child be put upon a stimulating diet.

PROSTATIC CALCULUS.

Prostatic Calculus differs from all other urinary concretions in situation and composition, being formed in the ducts of the prostate gland, and composed principally of phosphate of lime and some animal matter; usually about 85 per cent. of the phosphate, to 15 of the organic ingredients. The concretion is said to consist sometimes of carbonate of lime (p. 989). It generally occurs in old people, though it may sometimes be met with in young subjects. From a lad of nineteen, whom I cut for vesical calculus, I extracted two prostatic concretions.

Characters.—Prostatic calculus is usually of a grey or ashy colour, somewhat triangular in outline, smooth and polished (Fig. 931), having facets, being very hard, and seldom much larger than a cherry or plumstone; though it may occasionally attain a considerable bulk, having been met with as large as a hen's egg, and then presenting a branched or irregular appearance. Though usually but one or two exist, which are sometimes deposited in a kind of cyst in the organ, as many as thirty or forty have been met with, the ducts being filled, and its whole tissue being studded with them.

Symptoms.—Calculus in the prostate gives rise to a sense of weight, pain, and irritation in the perinæum, sometimes to retention of urine, and, in fact, to the ordinary symptoms of enlarged and irritated prostate; it often occasions a tolerably free discharge of mucus in the urine. On introducing a sound, this passes over the stone, sometimes rubbing or striking it with a distinct grate or click before its beak enters the bladder. This is increased by the finger in the rectum pushing the organ up, and thus bringing the stone into more direct contact with the sound. In some instances the calculus is deeply imbedded in the prostate, and cannot be touched by the sound. In these cases the stone may usually be felt through the rectum. If there be many small calculi in a sacculus in the prostate, they may be felt by introducing the finger into the rectum, when a peculiar crackling or grating sensation may be experienced by the rubbing together of the calculi, something like that produced by beads in a bag.

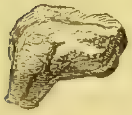


Fig. 931.—Prostatic Calculus.

Treatment.—The treatment of prostatic calculus will depend upon the situation, size, and number of the concretions. When they are large, single, or at most two or three in number, readily struck with the sound, and situated on the urethral surface of the organ, the ordinary median operation may advantageously be performed, and the calculus removed with a scoop or forceps. If the calculi be small and very numerous, not to be felt with the sound, but only through the rectum, it will be wiser not to have recourse to operation, which could not remove the whole of the concretions. In such circumstances, a palliative treatment directed to the subdual of the irritation of the prostate, and the use of the catheter to relieve retention, is the only course to pursue. When prostatic and vesical calculi occur together, the same operation will rid the patient of both forms of the disease.

For Foreign Bodies in Bladder, see Vol. I., p. 894.

CALCULUS IN THE FEMALE.

Stone is of rare occurrence in women; in London, certainly, it is not often met with. Thus, South states that, during a period of twenty-three years, 144 males were operated on for stone at St. Thomas's Hospital, and only 2 females. In some districts, however, stone would appear to be more common in women than this. Thus, according to Crosse, at the Norwich Hospital, the proportion has been about 1 woman to 19 men. Civiale states, as the result of his researches, that in the North of Italy, the proportion is 1 to 18; and in France, about 1 to 22. At the University College Hospital we had not had a case of stone in the female for many years until 1855, when three came under my care in the course of a few months; and since that period many have occurred.

Vesical calculi in the female are often nothing more than phosphatic incrustations deposited around some foreign body that has, either accidentally or from depraved motives, been passed up the urethra. In this way hair-pins, pieces of bougie, of catheter, or of pencil, will often be found to form the nucleus of the concretion.

Symptoms.—The symptoms of stone in the female closely resemble those that occur in the male, and its presence may usually be easily detected by means of a short and nearly straight sound, or a female catheter. It is often simulated very closely by the irritation occasioned by a vascular urethral tumour, or by an irritable bladder; but exploration of the viscus will always determine the diagnosis. The larger calculi can be felt from the vagina if firm pressure be made at the same time above the pubes.

Large calculi may be met with in very young female children. I have removed a uric acid calculus incrusted with phosphates, measuring $1\frac{1}{4}$ inch in length by $\frac{3}{4}$ inch in breadth, from a little girl four years old. The stone was removed unbroken, by gradual dilatation of the urethra. In the adult they may attain a very large size. I have extracted one from a young woman measuring 8 inches in its long, and 6 inches in its short circumference.

Calculus in the female bladder, if allowed to remain unrelieved, will not only occasion the various morbid conditions in the urinary organs that have been described as following the long-continued presence of stone in the male, but will give rise to diseased states peculiar to the female. Thus the stone may be spontaneously discharged through the urethra; if of small size, without any bad results following; but if large, by a process of ulceration, in consequence of which permanent incontinence of urine will remain: or it may slough through into the vagina: or lastly, it may offer a serious obstacle during parturition to the descent of the fœtal head, when, if it cannot be pushed aside to be dealt with afterwards, it must be cut out, or craniotomy be performed.

Removal.—A stone may be extracted from the female bladder by one of three methods: 1, by Lithectasy, through a dilated urethra; 2, by Lithotomy; 3, by Lithotrity. These different operations cannot be employed indiscriminately, but each one is more especially adapted to certain kinds of calculus.

1. **Lithectasy** may be performed in two ways—either by simply *Dilating the Urethra*, or else by *Incising the Mucous Membrane* at the same time that the canal is being expanded.

a. **Simple Dilatation** of the urethra may be effected quickly by the introduction of a three-bladed dilator, which is rapidly screwed up. In this way, in a few minutes the canal may be easily dilated sufficiently to allow the introduction of a pair of forceps, and the extraction of a calculus of moderate size. Some Surgeons prefer a slow process of dilatation, continued through many hours, by means of a sponge-tent; but this appears to me to possess no advantage over the more rapid method, and has the very decided disadvantage of prolonging the patient's sufferings. In the absence of a proper urethral dilator, it is always easy to dilate the canal by means of the finger. With this view a director is first passed, and along this the Surgeon gradually insinuates the tip of his finger, and then soon succeeds in expanding the urethra sufficiently for all ordinary purposes.

b. **Dilatation** may be employed conjointly with **incision**, in order to prevent injurious stretching of the urethra, and consequent laceration of its mucous membrane. The incision should be made after the urethra has been dilated to some extent, a probe-pointed bistoury being introduced by the side of the canal, and the mucous membrane divided. Brodie made an incision directly upwards; Liston downwards and outwards on each side—on the whole, I think, the best direction for the incisions, as more space may thus be obtained.

By dilatation, either alone or with incision of the mucous membrane, small stones may readily be extracted; and those calculi that are formed by the phosphatic incrustation of foreign bodies, may be removed in this way. I have thus extracted, by dilatation, a full-sized gum-elastic bougie from the bladder of a young woman. In the removal of moderate-sized calculi, however, the great objection to this operation is the liability to incontinence of urine resulting from it. It is difficult to say to what extent the urethra may be dilated without incontinence resulting; this must necessarily vary in different individuals. It certainly can be expanded sufficiently to allow the introduction of the index finger, and the extraction of a stone eight or ten lines in diameter, without any evil resulting. The incontinence of urine that may be left after the removal of larger calculi than this may not be by any means complete; but a weakened state of the sphincter of the bladder results, so that the patient cannot hold her urine for more than an hour or two at the most.

2. **Lithotomy** in the female may be performed in a variety of ways. There are, however, only three modes of practising this operation that appear to me to deserve serious attention; viz., the *Suprapubic*, the *Urethral*, and the *Vaginal.*

The **Suprapubic** or **high** operation in women differs in no very material respect from the same procedure in men; except that it requires additional care in consequence of the difficulty there is in causing the female bladder to retain enough urine or water to make the viscus rise sufficiently above the pubes. The extraction of the stone is easy, as it can be raised into the grasp of the forceps by being pushed up from the vagina.

Urethral Lithotomy is a simple and efficient operation. It consists in placing the patient in the lithotomy position, and tying her up. A grooved staff is then introduced into the bladder, and a sharp-pointed bistoury, guided by it, is pushed through the floor of the urethra, about an inch and a half from the meatus, the canal being divided directly downwards. The forceps may then be readily carried into the bladder, and a calculus of good size removed.

After the bladder has been cleared, a full-sized catheter should be introduced, and left in the bladder, and the cut edges of the urethra brought together over it by two or three points of silver suture.

Vaginal Lithotomy is an operation easy of performance. It may be practised by passing a straight grooved staff into the bladder, pressing the end well down against the anterior wall of the vagina, and fixing it there with the left index finger. A scalpel is then pushed through the anterior wall of the vagina and inferior fundus of the bladder into the groove in the staff, which is made to enter just behind the urethra, and is then run backwards for about 1½ inch; through the aperture thus made the forceps is passed, and the stone extracted. The incision into the bladder through the anterior vaginal wall should be brought together by metallic sutures, as in ordinary operations for vesico-vaginal fistula, and may thus be successfully closed, as has been done by J. Lane, Aveling, and others.

On **Comparison** of these three operations, *urethral lithotomy* is certainly the easiest, the least severe at the time of its performance, and the least likely to be attended by evil after-consequences, but it is only applicable to small stones. The only evil that may result from it is the want of union of the incision, an accident very likely to follow if a large calculus is extracted by this method. Should this occur, a plastic procedure must be undertaken at a subsequent period to remedy the defect.

Both the high and the vaginal operations are easy of performance. In the *high* operation, there would, with care, be but little risk of injuring the peritoneum; and the chance of urinary infiltration may be prevented by the introduction of a siphon-catheter into the urethra. The *vaginal* operation, though easier of performance, is open to the objection of possibly leaving a permanent urinary fistula. If, however, the lips of the incision have not been bruised by the forceps, or in the extraction of the stone, and be immediately brought together by metallic sutures, the risk of a fistula is, after all, not great. Vaginal lithotomy may, in some cases, be the only alternative. I extracted, by this operation, a calculus measuring eight inches by six in circumference, from the bladder of a woman twenty-three years of age, who had suffered from symptoms of stone from childhood. The stone by its size offered so serious an obstacle to the descent of the fœtal head during parturition, that craniotomy had been rendered necessary; the anterior vaginal wall had been a good deal bruised, and I feared that sloughing of it might take place; hence I extracted the stone by the vaginal method. As a rule the high operation is to be preferred, all stones of moderate size being extracted by simple dilatation or by lithotrity.

Lithotomy is not so dangerous an operation in the female as in the male; yet death occasionally occurs, especially in feeble children, from cystitis and peritonitis, more particularly if the extraction of the stone have been tedious and difficult, the bladder being much manipulated.

3. **Lithotrity** in the female requires to be practised on the same principles as in the male. The details of the operation differ, however, in some important particulars. The chief obstacle in the performance of the operation in the female, consists in the difficulty with which the bladder retains urine or water that is injected into it. In consequence of this there is not only great difficulty in seizing the stone, the bladder collapsing and falling into folds around it, but also danger of injuring the mucous membrane with the lithotrite. In

order to cause the bladder to retain the necessary quantity of urine, the pelvis must be well tilted up, and the urethra compressed against the lithotrite. It is well not to dilate the urethra before the introduction of the instrument, as the incontinence is thereby increased.

The ordinary male lithotrite is not a very convenient instrument to use in the female bladder, the handle being awkwardly long. This is especially the case in female children. Hence I have found it convenient to have a shorter instrument constructed, with which it is far more easy to work in the female bladder. The lithotrite is now always used, even for very large stones, such instruments as that represented in Fig. 932 being scarcely ever employed. The stone should be completely pulverized, as in the male, and the fragments removed in the same way with an evacuator and large catheter. This plan is much better than that sometimes recommended of dilating the urethra and extracting the pieces with forceps, as in this proceeding the sharp fragments are very likely to lacerate the mucous membrane. The whole stone must be removed at one sitting.

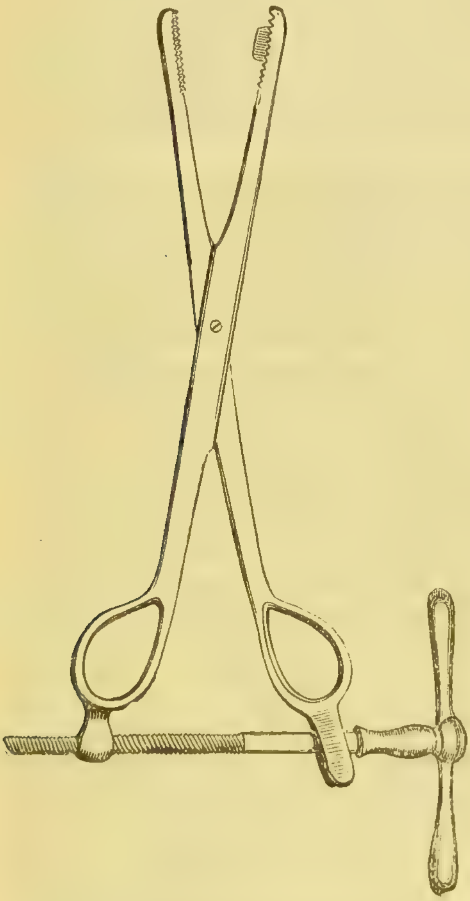


Fig. 932.—Crusher for large Calculus in Female Bladder.

For all calculi in the female bladder, except those of the very largest size, this operation is the most applicable. I have in this way crushed and extracted at one sitting, from the bladder of a lady about 50 years of age, a phosphatic calculus fully as large as a hen's egg. By this operation the stone may be removed at once, without the necessity of dilating the urethra to such a degree as to incur the risk of incontinence of urine resulting. Lithotrity may be had recourse to at all ages, in the very young as well as the old. I have crushed and successfully removed a large calculus from a child three and a half years of age, the youngest patient on whom I have operated by this method. Although the urethra of so young a female child cannot, without danger of incontinence, be much dilated, yet it may safely and easily be enlarged sufficiently to admit a moderate-sized lithotrite.

CHAPTER LXX.

DISEASES OF THE BLADDER.

CONGENITAL MALFORMATION.

Extroversion of the Bladder, consisting in an absence of the anterior wall of the organ, with deficiency in the corresponding part of the abdominal parietes, is a congenital malformation occasionally met with. It may occur in either sex, but is more common in males.

This condition consists in an arrest of development, in consequence of which the anterior part of the pelvic girdle is deficient, the bodies of the pubic bones being imperfectly developed and the symphysis absent. The recti muscles separate at their lowest part, and pass obliquely outwards to be inserted into the lateral abutments of the pubic bones. A triangular space is thus left, which is filled up by the posterior wall of the bladder, which is continuous with the common integuments, the anterior wall being absent, and the interior of the bladder exposed. The cleft commonly extends up to the spot at which the umbilical cord enters, so that the umbilicus is wanting. The penis is cleft along its dorsal aspect, exposing the floor of the urethra, forming the condition known as epispadias. The posterior wall of the bladder, being pushed forwards by the pressure of the abdominal viscera behind, forms a rounded tumour about the size of a small orange just above the pubes. The surface of this tumour is red, vascular, and papillated, evidently composed of mucous membrane ; at its lowest part the orifices of the ureters will be seen discharging urine in drops or in a stream. For a full description of the mechanism of the passage of the urine in this malformation, I would refer to a case which fell under my notice, and in which I made a number of experiments on the rapidity of the passage of foreign matters through the kidneys, reported in the *Medical Gazette* of 1845.

This malformation is of the most distressing kind. The odour constantly exhaled from the patient by the dribbling and decomposition of the urine is a source of annoyance to himself and of disgust to others. In order to render his presence at all tolerable to others, this dribbling must be prevented by some mechanical contrivance. With this view the patient should wear a properly constructed instrument to collect the urine, consisting of a hollow shield strapped over the part, communicating by means of a tube with an india-rubber bottle, which may be attached along the inside of the thigh.

Treatment.—Up to a comparatively recent period this condition was considered incurable. Of late years, however, operations have been devised and practised with the view of covering in the exposed bladder, forming an anterior wall to the viscus, and restoring the urinary canal ; so as to protect the tender extroverted surface of the bladder, to prevent the pain and irritation arising from contact of the clothes with it, and, by giving a proper conduit to the urine, to which an apparatus can be applied, to save the patient all the annoyance of constant dribbling.

The first operation for the remedy of this malformation that was successfully performed was done, in 1859, by Ayres of New York, in the case of a young woman 28 years of age. He, consequently, has the merit of having been the pioneer in this branch of Surgery. He was followed by Pancoast of Philadelphia, and subsequently by Holmes and Wood of London.

Ayres's Operation.—The operation practised by Ayres comprised two steps. The first consisted in dissecting down a long flap of integuments and of superficial fascia from the anterior wall of the abdomen above the bladder, and turning this down so that the cuticular surface was innermost and lay over the exposed bladder as far as the inferior border. Lateral union was then secured in this position, but the lower part of the flap was left open, so as to allow a free exit for the urine. In this way the bladder was covered in completely by a skin flap, having its cuticular surface underneath, and consequently next to the exposed vesical mucous membrane. The integuments of the abdomen were now sufficiently separated from their areolar connections with the muscles beneath, on each side of the reversed flap, to admit of their sliding forwards, and being united by sutures along the mesial line, so as completely to cover in the exposed raw surface of the flap. In this way the bladder was overlaid by integumental structures, which readily united along the mesial line; and were the patient a male, little more would require to be done than to dissect up the integumental structures below this flap, and so to close in the epispadias and form an anterior wall to the urethra. In Ayres's case, as the patient was a female, the second step of the operation, which was practised after a lapse of three weeks, consisted in fashioning a covering for the vulva, by dissecting up the integuments covering the pelvic bones on each side, and uniting them to one another on the mesial line and to the lower part of the reversed flap.

The principle of the operations adopted by Pancoast, Holmes, and Wood, is essentially the same as that practised by Ayres—viz., that of raising integumental flaps from the abdominal wall, and covering in the bladder by turning the cuticular surface of these flaps towards it. But the details of the operations differ chiefly in this, that the flaps have been taken from the groins and lateral aspects of the abdominal wall, with their bases downwards, so that they might be nourished by the superficial branches of the common femoral artery.

Wood's Operation.—A flap composed of the skin and areolar tissue of the abdominal walls above the extroverted bladder is first dissected up. This flap is somewhat square in shape, and its base should correspond in width with the exposed mucous membrane of the bladder. Its length should be sufficient to cover the whole of the exposed mucous membrane. The flap is turned down with its skin-surface towards the bladder. Then a "pyriform flap," the base of which is about equal in width to the length of the "umbilical flap," is dissected up from each groin, the base of the flap being "directed towards the scrotum and thigh" (Fig. 933). These two flaps are brought together so as to meet in the median line, and to cover in the umbilical flap, the raw surfaces of the two groin-flaps being in contact with the raw surface of the reversed umbilical flap. The flaps are then secured in position by hare-lip pins, each pin passed so as to transfix both the groin flaps and a fold of the umbilical flap beneath, holding the three firmly together (Fig. 934). No sutures are required in the flaps. The edges of the wounds left in the places from which the flaps have been raised are then brought together by hare-lip pins and wire sutures (Fig. 934), and broad strips of plaster placed across so as to support the parts and to remove as far as possible any tension from the flaps. The patient must be kept in bed in a sitting posture, with the knees drawn up.

If the operation be successful, all the pins and sutures may be removed by about the sixth or eighth day, and cicatrization will probably be complete before the end of a month; the exposed surface of the bladder being completely covered in, leaving only a small opening about the root of the fissured penis, to which an apparatus may be readily adapted to catch the urine. If the umbilical flap be not of sufficient length, very troublesome fistulæ are apt to be left at its angles, requiring further plastic operations for their cure. Experience has shown that, if the operation be left at this stage, the benefit is not permanent. The contraction of the cicatrices, and the constant tendency to protrusion of the mucous membrane of the bladder from beneath the new covering at the opening left at the root of the penis (Fig. 934), lead to a gradual increase in the size of the opening and a partial return of the symptoms. To

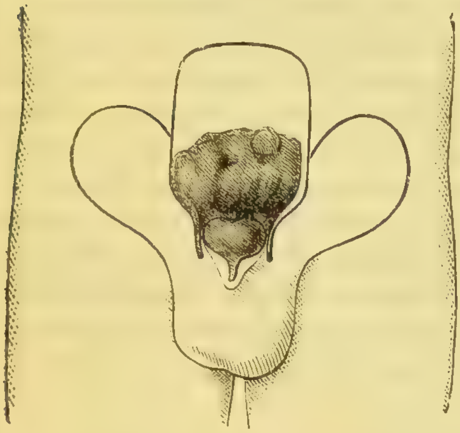


Fig. 933.—Wood's Operation for Extroverted Bladder. Outline of Incisions.

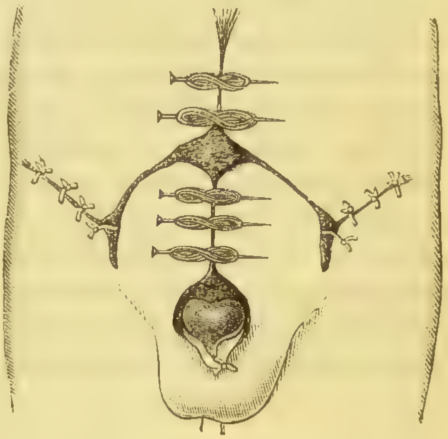


Fig. 934.—Wood's Operation: Flaps applied.

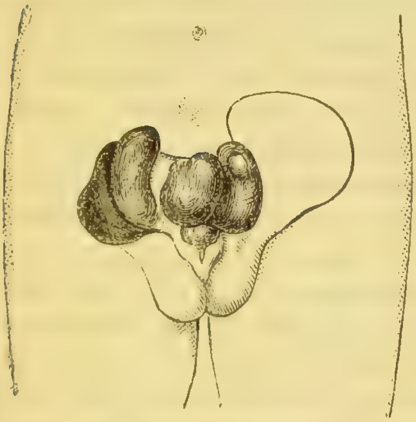


Fig. 935.

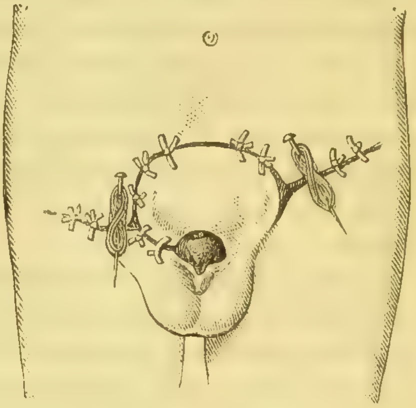


Fig. 936.

Wood's Operation by Lateral Reversed Flaps. (After Wood.)

prevent this, the fissured penis may be covered in by the following method. The whole front of the scrotum, including the dartos, is raised so as to form a bridge of skin connected with the groin at each side. This is lifted over the penis, and placed upon a raw surface prepared by turning down a collar or flap from the lower arched border of the new bladder-covering and from the sides of the urethra and penis as far forwards as the glans. A continuous wire suture is applied to keep the flaps in place ; and the transplanted scrotal structures are united to the border of the bladder-covering by a line of interrupted sutures. The scrotal wound is readily closed by wire sutures. By this means a sort of urethra is formed, containing the muscular tissue of the dartos in its roof, which may even give it a slight power of contraction, so as to enable the new bladder to contain small quantities of urine. The second stage of the operation is often somewhat interfered with by erections of the penis. These are best controlled by ice-bags. The knees should be drawn up so as to relieve tension, especially in the first stage of the operation. After the cure is complete, the patient is often troubled by the growth of hair from the under surface of the umbilical flap, and the accumulation of phosphates upon the hairs and in the angles of the new bladder. This is best relieved by extracting the hairs with a pair of forceps, and by using weak acid injections to remove the accumulation of phosphates.

CYSTITIS.

Idiopathic inflammation of the bladder is of rare occurrence. When it is met with it is usually in gouty subjects from exposure to cold. Acute cystitis most commonly originates from traumatic causes, as from the passage of instruments, the irritation of broken fragments of calculus, &c. Occasionally it arises from the extension of gonorrhœa to the interior of the organ. It may be caused also by certain irritant poisons, of which cantharides is the most important. Occasionally it is directly dependent on decomposition of retained urine, but more commonly this aggravates inflammation originating from other causes.

Acute Cystitis.—The **Symptoms** of cystitis consist not only in local pain and weight in the hypogastric and iliac regions, with tenderness on pressure in these situations, and a good deal of constitutional irritation ; but in the existence of extreme irritability about the bladder. As soon as a few drops of urine collect, they excite so much irritation that they cannot be retained, and are expelled by a kind of spasmodic or convulsive effort, constituting *strangury*, often accompanied by a good deal of tenesmus and great suffering. The urine will be found to be high-coloured, mixed with more or less mucus or pus, and often tinged with blood.

Termination.—An acute attack of cystitis usually terminates in the chronic form of the disease, and thus gradually undergoes resolution. Occasionally, however, it terminates fatally ; and when this is the case, the urine becomes excessively foul, and death takes place from septicæmia, suppurating kidney, or more rarely from peritonitis. The temperature, which at first may have been elevated, gradually sinks, the tongue becomes brown and dry, the pulse rapid and weak, and the patient sinks into a drowsy semi-comatose state before death. On examination after death, the bladder is found to contain foul urine mixed with mucus ; the mucous membrane is of an intense purple colour, and frequently covered in parts by an adherent membranous layer almost like that of diphtheria. In other cases the inflammation has gone on to gangrene of the mucous membrane, collections of pus may be found in the substance of the wall of the bladder, and not unfrequently the peritoneum is implicated and diffuse peritonitis set up. Occasionally the bladder has been perforated, and infiltration of urine in the deep areolar tissue of the pelvis may be met with. Very commonly the mischief has extended to the ureters and kidneys.

Treatment.—The first step in the treatment is, if possible, to render the urine less irritating by diluting it by the free administration of barley-water or mucilaginous drinks, and by giving liquor potassæ or bicarbonate of potash in doses sufficient to neutralize it. The patient must be confined to bed, and hot fomentations or poultices applied over the lower part of the belly. Long-continued hot hip-baths usually give great relief. To these means may be added the administration of henbane in full doses and morphia suppositories. No specific medicines are of any use. No instruments should be used during acute cystitis if they can possibly be avoided ; but should the urine become foul, an attempt may be made to wash out the bladder, as the mechanical irritation of the catheter is a less evil than an accumulation of putrid mucus and urine. If it be necessary to do this, great gentleness must be used, the quantity of fluid injected being limited to about an ounce. The diet must be carefully regulated ; no salt or spiced food must be allowed. As a rule a pure milk diet will be found the best.

Chronic Cystitis.—Chronic cystitis is by far the most common morbid condition of the bladder. It may follow acute inflammation, the intensity of the process gradually subsiding, or it may from the first be chronic. It is met with in all cases of stone in the bladder after the disease has existed for a certain time ; in all old and tight strictures ; and it is the inevitable consequence of the presence of decomposing urine in the cavity of the bladder. In some cases it is apparently of gouty origin ; but perhaps the most persistent form is that which sometimes follows gonorrhœa, which may be acquired in youth, and lead to life-long misery.

Pathological Changes.—On examining the bladder of a patient who has suffered from chronic cystitis, the mucous membrane will usually be found to be of a dark grey or slate colour. As in most cases there has been some exacerbation of the condition immediately before death, dark red or purple patches are usually seen in various parts, especially on the summits of the rugæ. Dilated and tortuous veins commonly ramify on the surface, the blood in which is usually blackened by the contact of the decomposing urine after death. The mucous membrane is tougher and thicker than natural, and not uncommonly there is distinct thickening with induration of the submucous tissue. Ulceration of the mucous membrane is occasionally met with. The muscular coat of the bladder is seldom unaltered, as in the great majority of cases chronic cystitis is associated with conditions which interfere with free micturition. If the obstruction has been of such a kind that no amount of increased force could have emptied the bladder, as in many cases of enlarged prostate, the bladder is dilated, and its muscular coat may be thinned and atrophied with an excess of fibroid tissue between the muscular elements. In cases of stricture of the urethra, and other obstructions which can be overcome by increased force, the bladder is usually contracted, and its muscular wall greatly hypertrophied and thickened. The hypertrophied fasciculi of muscular tissue form folds or ridges beneath the mucous membrane, having irregular depressions between them, so as to cause the interior of the bladder to resemble somewhat the inside of one of the cavities of the heart, with its projecting columnæ carneæ. The hypertrophy is usually dependent on the same cause that has given rise to the chronic inflammation, but in some cases cystitis alone may cause the hypertrophy. It would, then, seem to be due to the obstruction caused by the thick ropy mucus, which requires greater force for its expulsion than healthy urine, and it is consequently only an indirect effect of the inflammation. Sacculi are commonly found projecting at the posterior and lateral parts. These are of two kinds, both of which are formed by projections between the fasciculi of the wall of the bladder. In the first and least common kind, the muscular as well as the mucous coat is pushed outwards ; in the second form, the mucous coat alone forms a kind of hernial protrusion (Fig. 937). In the sacculi thus formed, accumulations of various kinds may take place ; mucus, pus, phosphatic deposits, and even calculous concretions, not unfrequently being met with in these situations. The urine, mixed with mucus and pus, retained in these pouches, where it undergoes decomposition, is the cause of the great fetor of the urine in such cases, and of the difficulty in cleaning such bladders by washing them out. Sometimes ulceration takes place as a consequence of the irritation of the fetid accumulation, and perforation may occur, followed by peritonitis and death. Ulcerations of the mucous membrane and abscesses in the submucous tissue are occasionally met with in bladders which have suffered from chronic cystitis, but they are usually the result of the exacerbation that often sets in before death. The effect of chronic cystitis in causing disease of the kidney has already been described (p. 957).

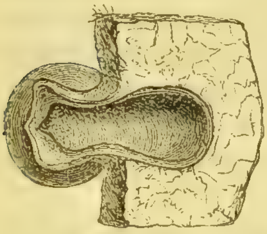


Fig. 937.—Sacculus in the Wall of the Bladder.

Symptoms.—Chronic cystitis gives rise to symptoms closely resembling those of the acute form but differing in degree. The diseased and tender bladder is unable to bear more than a slight degree of distension without pain, consequently there is a frequent desire to pass water, and the urgency is such that the slightest delay gives rise to considerable suffering. This *pain before micturition* is always one of the most prominent symptoms. The fluid is generally ejected forcibly or even spasmodically, and in small quantities at a time. Its passage may be attended by some pain, but seldom enough to be termed strangury. If the cystitis is not complicated by stone there is distinct relief after micturition. The urine is turbid, and always contains an excess of mucus. In slight cases this is small in amount, but more commonly it becomes abundant, viscid, and glutinous, requiring some force and straining for its expulsion, forming the condition known as *Catarrh of the Bladder.* The urine then, unless special means are taken to prevent it, becomes ammoniacal and fetid, and often mixed with much pus. The urine, on standing, separates into two parts, the upper being clear, but the lower consisting of a thick, viscid, slimy or gummy mucus, often semi-opaque and purulent in appearance ; it sticks tenaciously to the bottom of the pot, and when poured out hangs from the edge in long stringy masses. It often contains triple phosphate crystals in large numbers. The alkaline condition of the urine in vesical catarrh is due to the formation of ammonium carbonate from decomposition of the urea.

The cause of this change is a question of great importance, as the irritation of the ammoniacal urine in the bladder is one of the most important causes of the persistence of vesical catarrh. It is generally recognized that it takes place by a process of fermentation, but the exact nature of the ferment has been a matter of dispute. All urine undergoing ammoniacal fermentation is found to contain microscopic organisms, often of various kinds. The most constant is a small round fungus or micrococcus, but with this, rod-shaped organisms or bacteria showing active movements are almost invariably present. These organisms are very generally regarded as the actual ferment, and they are supposed to be carried into the bladder in most cases by instruments used in the treatment of the various conditions upon which the cystitis is dependent. The evidence in favour of this view cannot be fully discussed here, but it may be briefly stated that experiments by Lister and others have shown that healthy urine drawn from the bladder with proper precautions against the admission of organisms from the air, into vessels which have previously been heated or exposed to the flame of a spirit lamp, shows no tendency to undergo spontaneous decomposition, and may be preserved for months in contact with filtered air without becoming ammoniacal. It is not uncommon, moreover, in practice, to meet with cases in which the patient has been unable to empty his bladder completely for many months in consequence of prostatic disease, and yet the urine has remained acid and free from decomposition throughout; at last a catheter is passed, and within three days the urine is decomposing and strongly ammoniacal.

These facts seem to suggest strongly that the ferment is carried into the bladder from without. Cases are however not unfrequently met with in which the urine is foul, and yet no instrument has ever been passed. In these the explanation suggested is that the mucus secreted as the result of cystitis hangs in the urethra, which is not washed clean at every act of micturition, and constantly forms a channel of communication between the external air and the bladder by means of which decomposition may extend into the bladder. Urine which is mixed with a considerable proportion of alkaline mucus decomposes far more readily than the healthy secretion.

The constitutional symptoms of chronic cystitis are chiefly due to the disturbance at night and want of rest, unless the urine is allowed to become foul. If this happen, the ordinary symptoms of chronic septic poisoning usually manifest themselves, irregular febrile disturbance, loss of appetite, foul tongue, and progressive emaciation.

Chronic cystitis is not unfrequently fatal, death resulting in most cases from septicæmia, or from extension of decomposition to the urine in the ureters and pelves of the kidneys with suppurative nephritis. These conditions are accompanied by the symptoms already described. Occasionally, in old patients, the constant disturbance may cause death by exhaustion.

Treatment of Chronic Cystitis.—The treatment of chronic cystitis must always have reference to its cause. If it be due to stone or stricture no permanent improvement can be obtained till these causes are removed, but before undertaking this, if the symptoms are verging on those of the acute form, hot hip-baths, fomentations, mucilaginous drinks, henbane, with alkalies, and especially potash, will be found most useful. The bowels must be kept regular by enemata or castor oil. If there should be strangury, morphia or belladonna suppositories will give most relief. By these means the disease may be prevented from assuming the form of chronic vesical catarrh ; but in order to ensure this it is most important that decomposition of the urine should be prevented, or if it have already commenced that it should be arrested. For the prevention of the decomposition all instruments should be washed in carbolic acid lotion (1 in 40) before being used, and then greased with "Lund's oil," composed of absolute phenol, 1 part, castor oil, 4 parts, and olive oil, 15 parts ; or with the following, which has the advantage of not crystallizing in winter : absolute phenol, 1 part ; castor oil, 7 parts ; and almond oil, 8 parts. The penis may also be washed with boracic acid or carbolic acid lotion after micturition and covered with lint soaked in glycerine of carbolic acid or a piece of salicylic wool. If the urine has once become foul it becomes necessary to adopt local means to correct it. No good can be expected from medicines so long as the bladder is full of putrid mucus and urine. The bladder must therefore be washed out with some antiseptic solution, once, or if necessary, twice daily. This is done as follows : a soft catheter is passed and the urine drawn off ; about two ounces of fluid are then thrown in from an india-rubber bottle fitted with a brass nozzle and stop-cock. The fluid is then allowed to run out again, and this is repeated till that which comes back is quite clean. Nothing is gained by injecting larger quantities, which only cause needless pain and irritation. There is another method of washing out the bladder which will often be found useful. It consists in attaching an india-rubber tube, about three feet long, to the catheter. At the other end of the tube is a glass funnel. By raising the funnel about two feet above the patient's body and pouring the fluid into it, sufficient force will be obtained to fill the bladder. When sufficient fluid has entered, the funnel may be allowed to hang over the side of the bed over a vessel, when the fluid will be withdrawn from the bladder, the tube acting as a syphon. Amongst the most useful of all antiseptic injections is permanganate of potash ; the solution may be injected repeatedly till it comes back purple. Its effect is, however, very temporary, and it is well after the bladder has been cleaned by Condy's fluid and water to throw in a small quantity of some more powerful antiseptic. Perhaps the best of these is quinine, in the strength of two to three grains to the ounce of water, with a minim of dilute sulphuric acid added for each grain ; of this about one drachm may be left in after the catheter is withdrawn. Other antiseptics are also useful, as boracic acid (a concentrated solution) ; bichloride of mercury (gr. $\frac{1}{8}$ to ℥j.), a concentrated solution of thymol ; dilute nitric acid (m. ij. to ℥j.), &c. One of the most efficient of all antiseptics I have found to be iodoform, in the proportion of from two to four grains to the ounce of water, with a little mucilage to suspend it. The only drug which seems to exert any influence over the decomposition of urine in the bladder is benzoic acid. This becomes converted into hippuric acid, and is discharged in that form with the urine. It may be given in ten-grain doses three or four times a day, either in pill or in a mixture containing mucilage to suspend it.

When by these means the urine has been brought into a tolerably healthy condition, so far as putrefaction is concerned, there still may continue a considerable excess of mucus which renders it prone to decompose, and unless constant care is exercised the patient may speedily relapse. To check this various astringent injections are sometimes of use, such as tannin (gr. j to ℥j) ; acetate of lead (gr. $\frac{1}{4}$ to ℥j) ; or nitrate of silver (gr. $\frac{1}{4}$ to ℥j).

Simultaneously with antiseptic or astringent injections, medical treatment may also be carried out. The greatest benefit will be derived from stimulating and balsamic diuretics such as buchu, uva ursi, and triticum repens ; but these remedies are useless, unless taken in quantities of a pint or a pint and a half in the day. The best of these is buchu. The infusion should be made freshly every day by putting half an ounce of the leaves in a tea-pot and pouring a pint of boiling water on them. It should be taken cold, and the whole pint consumed in the 24 hours. When the disease is very chronic no remedy appears to me to possess so much influence over the mere ropy mucoid discharge as the balsam of copaiba. Turpentine, cubebs, and tincture of the sesquichloride of iron, will be found useful. It is often difficult to say beforehand which diuretic will suit best, and I can lay down no precise rules to guide the practitioner in this respect. But they may often be tried or alternated with advantage. In many cases great relief is obtained from each new remedy, but it is not maintained.

The diet must be very carefully attended to ; no hot or spiced food should be allowed, and little or no salt. Alcoholic stimulants are better entirely avoided, but should any be required weak gin, or Hollands and water, or whisky and water are the best. Coffee must be strictly forbidden, but weak tea may be taken without restraint. Much benefit may often be derived from a pure milk diet for some weeks if the patient can bear it ; if it prove too rich the cream may be taken off. A course of one of the alkaline mineral waters may sometimes prove of service, especially in gouty subjects. The body must be warmly clothed and all exposure to cold avoided.

Irritability of the Bladder.—This is not a disease ; it is merely a symptom. It is of very frequent occurrence and is met with at all ages, and arises from a great variety of causes. It consists in a frequent desire to pass water, not dependent on an increase in the quantity of the secretion. The desire is usually so urgent as to amount to actual pain, and in extreme cases it is impossible to delay the act by any voluntary effort. The urine is generally ejected forcibly, or even spasmodically, and in small quantities at a time. It may or may not be attended by strangury according to the cause, and the part affected. Strangury is most marked in those cases in which it is due to disease of the prostate or neck of the bladder. In some persons frequency of micturition may be merely a habit. It then occurs in the day only. If a patient is disturbed more than once at night to pass water true irritability exists.

Causes.—Irritability of the bladder may arise, as has already been stated, from a great variety of causes. These differ somewhat as the disease occurs in men, in women, or in children. The causes of irritability of the bladder in *men* may be arranged under the following heads.

1. *Morbid Conditions of the Urine.*—If this secretion be preternaturally acid and loaded with lithates or uric acid, it is especially apt to occasion an irritation of the bladder, attended by pain and a frequent desire to expel the offending fluid. Urine containing oxalates in large quantity is sometimes, though more rarely, a source of irritability of the bladder, which in these cases is perhaps increased by the morbidly sensitive state of the nervous system sometimes co-existing with these conditions of the urine. Amorphous phosphates passed at the end of micturition may cause severe pain, with a constant desire to pass water, lasting for an hour or less. It ceases as soon as the "alkaline tide" in the urine has passed (p. 988).

In *gout*, irritability of the bladder is not unfrequently met with. This may in some cases be owing to the acid character of the urine ; in others, to the excitation of a distinct gouty inflammation of the bladder and prostate, co-existing or alternating with the articular form of the disease.

2. *Renal disease*, more particularly the lodgment of a stone in the kidney, will often occasion sympathetic pains in the bladder, with much irritability of that organ, so as closely to simulate vesical disease, or even to lead to a suspicion of the existence of stone in the bladder. Tuberculous pyelitis will give rise to similar symptoms ; in fact in some cases the frequency of micturition may be greater than in almost any other affection of the urinary organs.

3. *Disease of the Bladder itself*, as a chronically inflamed state of its mucous membrane, will give rise to pain and irritation on the accumulation of a small quantity of urine, with a frequent desire for its expulsion. So, also, when the interior of the organ is fasciculated, or sacculated, and more especially if there be a tumour in a state of ulceration, a degree of morbid irritability will be induced, often of the most severe and intractable kind.

4. The *Lodgment of a Stone in the Bladder* will always, by its mechanical action, by its weight and pressure, by rolling about when the body is in motion, irritate the interior of the organ ; and, in fact, the "rational symptoms" of stone in the bladder are simply those of irritability of that organ.

5. *Inflammation, Ulceration, Abscess, Tubercle, or other Diseases of the Prostate*, and inflammation, gonorrhœal or simple, and abscess or stricture of the deeper portions of the urethra, also not unfrequently occasion irritability of the bladder.

6. *Various Diseases in Neighbouring Organs* will occasion this condition. Amongst the most frequent are fissure and ulcer of the rectum and anus, piles, prolapsus, intestinal worms, gall-stones, and varicocele.

Diagnosis.—The diagnosis of irritability of the bladder is made by the patient himself ; but it is often a matter of no little difficulty to the Surgeon to ascertain the precise cause of that irritability. This can of course be done only by a careful *surgical* exploration of the whole of the urinary organs, and often of the neighbouring parts ; no mere inquiry into the nature of the symptoms can do more than establish the fact of the existence of "irritability of the bladder," and afford some evidence of a negative kind as to the absence of certain causes. But nothing short of a careful surgical exploration by means of the catheter, finger, and sound, of the urethra, prostate, and bladder, can enable the practitioner to state with absolute certainty on what this condition of irritability depends. I have repeatedly seen cases of stone in the bladder, and of prostatic disease, vainly treated by medical means for months as cases of simple "irritability of the bladder ;" the existence of the real cause of the symptoms having been overlooked altogether, until a proper surgical examination of the urinary organs was instituted. So closely, in fact, do the symptoms of vesical irritation, arising from gout, or sympathetic with kidney-disease, simulate those that are occasioned by stone in the bladder, that it is impossible for the most experienced medical practitioner to refer them with certainty to the right cause without exploring this cavity. I have known several patients who had been operated on for stone, and who, some years afterwards, suffered from gouty irritability of the bladder, imagine, but erroneously, that they were labouring under a recurrence of the calculus, so closely do the two classes of symptoms coincide in character.

Cases, however, will be met with now and then, in which, in spite of the most careful examination and prolonged observation, no tangible cause will be found for the irritability of the bladder.

Treatment.—In the treatment of irritability of the bladder it must be borne in mind that this condition is not a substantive disease, but an assemblage of symptoms resulting from the influence of a great number of very various causes, which must first be removed before the bladder can recover its normal sensibility and tone. When once the occasioning cause has been removed, whether that be a calculus, or gout, or prostatic disease, or a pile, such local vesical irritability as may remain may be removed by alkaline and mucilaginous drinks. Sedatives may be of use ; some in one case, others in another. Opium and belladonna, either by mouth or in suppository, are amongst the best. Henbane, or Indian hemp, suits some patients ; and chloral is one of the most generally useful remedies. The diet should be carefully regulated, and warm hip-baths used frequently.

Cystotomy.—In cases in which no tangible cause can be found and removed, and which prove hopelessly intractable to every means of treatment local and constitutional, nothing can be more miserable than the state of the unfortunate victim of an "irritable bladder." In such extreme and long-continued cases in which the patient's life has become a burden to him, in which every constitutional remedy and local sedative has been unavailingly tried, the idea has occurred to Surgeons of incising the inflamed and diseased parts by an operation as for lithotomy. Guthrie, who in 1834 strongly recommended this procedure, states that Sir W. Blizard successfully practised it in several cases as far back as 1806, dividing the enlarged prostate and neck of the bladder with a double gorget. Verneuil has practised median cystotomy followed by drainage through an india-rubber tube with great success in many such cases. Lately, Sir Henry Thompson has advised digital exploration of the bladder in the way to be described with Tumours of the Bladder, as a justifiable proceeding in cases of hopeless irritability. In his hands it has greatly relieved and even cured many patients even when no definite disease was recognised by the finger. He drains the bladder in such cases for a few days through a rubber tube.

Irritability of the Bladder in Boys may, as in adults, arise from a variety of causes. Among the less common is stone, but this should always be excluded first by careful sounding lest time be lost in useless treatment of some other supposed cause. A long foreskin, especially with accumulation of the preputial secretion beneath it, or a phimosis, may give rise to considerable frequency of micturition and pain in a young boy. If neither stone nor phimosis be present the urine should be examined, and possibly a deposit of uric acid may be found, which is not uncommon in young children who are overfed or exposed to an impure atmosphere in a crowded city. If much mucus be present, or even pus, it may be due to chronic cystitis. This affection appears to be analogous to the strumous inflammations of the mucous membranes of the eyes, nose, and throat, that commonly occur in scrofulous children. In this condition the child passes water with great frequency and with much pain ; the urine is offensive, and usually phosphatic ; there is much uneasiness complained of about the groins and along the penis ; in fact, many of the ordinary symptoms of stone are present. On sounding the bladder, it will be found roughened, fasciculated, and often containing sabulous matters mixed with mucus. Occasionally, though rarely, tubercular disease of the urinary tract is met with in children. It presents the same appearances as in the adult. Irritable bladder in children is very frequently due to thread-worms in the rectum, which should always be sought for in all doubtful cases. More rarely it may arise from the presence of a rectal polypus.

The **Treatment** consists in removal of the cause when this is possible. In the strumous affection of the mucous membrane, if the urine be foul, the bladder must if possible be cleaned out as in the adult, should the child be old enough for this to be done. The bladder may also be washed out from time to time with a weak solution of nitrate of silver. Beyond this the treatment consists in attention to the general improvement of the health, in the removal of intestinal irritation, in the regulation of the digestive functions, and in the administration of copaiba in small doses, either alone or conjoined with a few minims of liquor potassæ.

Irritability of the Bladder in Women often simulates stone so closely, that it is only after very careful sounding that the Surgeon is satisfied that no calculus exists. This condition may arise from a variety of causes, similar to those described at p. 1087, as occasioning irritability of the male bladder. There are some conditions, however, in which it occurs, that are peculiar to women. 1. It may be a truly neurotic or hysterical affection. 2. It is often sympathetic : being connected with some local disease of the genito-urinary organs, with a vascular tumour at the meatus of the urethra, or with some congestive affection of the uterus, which will require to be cured before the bladder can be brought into a sound state. 3. Prolapsus of the anterior wall of the vagina, drawing down the corresponding portion of the bladder, will keep up this condition ; if so, the prolapsus must be cured by some plastic operative procedure. In all circumstances, however, when this state has once been set up, it is very difficult to remove. 4. In many cases it is undoubtedly due to the irritation produced by a morbid state of the urine, dependent on mal-assimilation, and usually connected with an excess of lithates. In cases of this kind, careful regulation of diet, and the administration of potash with henbane, will afford much relief ; but the complaint is of a very intractable nature, and under the most careful treatment will often continue for years. 5. In strumous girls it may be due to a congested, thickened, and irritated state of the vesical mucous membrane, similar to that which is met with in other parts of the body, as the eyelids, nose, and throat. It is commonly associated with a muco-purulent discharge from the vulva. In cases such as these, the patient requires to be put upon a general anti-strumous treatment, and the bladder should be mopped out with a very strong solution of the nitrate of silver. This is best done by dilating the urethra, passing a silver tube into the bladder, and then through it a small sponge-probang charged with the solution.

ATONY OF THE BLADDER.

By **Atony of the Bladder** is meant such a degree of weakness of this organ that its power of emptying itself is partially or wholly lost. It is in the great majority of cases a condition of old age, and is not to be confounded with paralysis of the bladder, such as occurs in cases of injury or disease of the spinal cord. In atony the nervous supply is unimpaired; it is the muscular tissue that is at fault. The muscular tissue of the bladder may be impaired from several causes. By far the most common is the chronic strain to which it is exposed in over-distension of the bladder from mechanical obstruction at its neck arising from enlargement of the prostate. In this condition, if the dilated bladder be examined microscopically, its walls will be found to contain a great excess of somewhat dense fibroid tissue, amongst which lie scattered patches of muscular tissue.

In some rare cases atony of the bladder may result from a single prolonged voluntary or involuntary over-distension. The structural changes just described would then of course not be present.

Besides these, there is another variety of atony of the bladder commonly met with in early middle life, though it may occur at any age. In all the cases in which I have seen this form of atony it has been the consequence either of gonorrhœal cystitis or of cystitis following lithotrity. It may lead to partial or complete retention. It is often, but not always, associated with vesical catarrh and fetid urine. This condition, when once it has become chronic, is, I believe, incurable. In it structural changes take place in the bladder consequent upon the extension of the chronic inflammatory process from the mucous membrane to the submucous tissue and muscular coat. Its walls become thickened, rugged and pouched. The bladder is able neither to retain the normal amount of urine, nor completely to empty itself. The retained urine usually undergoes decomposition, and this condition is very apt to end in fatal disease of the kidneys.

Excluding all these conditions there is yet another form of atony of the bladder which may be regarded as the most typical variety. It is essentially a condition of old age, and appears to be a senile degenerative change analogous to those of the heart and other organs so commonly met with at that time of life. Such a change occurring in a bladder causes its distension from slight causes of obstruction which could be readily overcome by the healthy organ of a younger man. Thus, we not unfrequently see a dilated atonic bladder occurring as the result of stricture of the urethra in an old man, instead of the contracted hypertrophied organ commonly met with as the result of this disease. A strong bladder may overcome a moderate amount of obstruction to the escape of the urine ; an atonic bladder utterly fails to do so. Thus, we see that a condition of atony of the bladder may occur in an otherwise healthy man from the obstruction of prostatic disease, while, on the other hand, a degree of obstruction that would be harmless to a healthy man may cause serious symptoms in one whose bladder is atonic to begin with. It is difficult to determine in most cases which is to be regarded as the primary condition. The fact that atony of the bladder is rarely met with in women would suggest that in the great majority of cases mechanical obstruction from enlargement of the prostate is to be regarded as the primary factor in the production of the disease.

Symptoms.—When this condition comes on slowly as the result of advancing years, the patient usually finds that the urine escapes in a dribbling manner ; that there is some difficulty, and at last an impossibility, in emptying the bladder completely ; that there is not that forcible ejection of the last drops of urine that is characteristic of a healthy tone in the organ ; at the same time, there is not unfrequently a tendency to the dribbling away of a few drops towards the end of the emission of urine, and after its apparent cessation. The patient feels a desire to pass water more frequently than usual. He cannot retain his urine for more than an hour or two—is often disturbed during the night, and if he does not at once obey the impulse, is apt to wet his clothes. This frequent desire to pass water is due to the bladder never emptying itself, a certain quantity—several ounces—of residual urine being left behind; by the addition of a small quantity the bladder becomes overloaded, and the desire to micturate is felt. Temporary relief is afforded, but as secretion continues the bladder soon fills up again, and so the process goes on. When complete retention occurs, whether this take place gradually or suddenly, the bladder slowly enlarges, rising out of the pelvis into the abdomen, stretching up into the hypogastric region, reaching even as high as the umbilicus. On examining the lower part of the abdomen, the organ will be felt hard, elastic, rounded, and pyriform in shape, projecting above the pubes, and feeling much like an enlarged uterus. In this situation, also, percussion will elicit a dull sound; and on exploring the part through the rectum, the bladder will be found to project in this direction also; and on tapping with the fingers above the pubes, fluctuation may be felt through the wall of the gut.

The distension of the bladder is sometimes so very gradual and slow, that the over-distended organ has been mistaken for an abdominal tumour. No pain and but little inconvenience is felt; the urine dribbles away; but at the end of two or three months the over-distended bladder is felt as a large, firm, elastic, and rounded tumour, stretching up to and perhaps above the umbilicus. Œdema of the legs may occur from its pressure on the iliac veins.

Atony of the bladder is a sufficient cause for incomplete retention of urine. But it does not appear to be adequate to explain the complete retention with distension of the bladder that is commonly seen. For this to occur there must be some mechanical obstacle, however slight, to the outward flow of the urine—contraction of the neck, or a congested or enlarged prostate. Could complete retention occur from a merely atonic bladder, we should meet with it as frequently in women as in men. It is the mechanical obstacle at the neck of the male bladder which intensifies the effects of its atony and leads to the complete stoppage.

After the bladder has once become distended, the retention may be complete, but it more commonly happens that a quantity of urine continues to dribble out of it; in fact, the amount that escapes in this manner may be very considerable, though the retention continue unrelieved. This *retention with dribbling* is a condition of much practical importance, as the continued escape of urine may lead the patient, and even the Surgeon, to overlook the true nature of the disease; the more so, as in elderly people retention slowly induced often occasions but little inconvenience. I have drawn off nearly a gallon of urine from a patient in whom it had not been suspected that retention existed, in consequence of the continuance of this dribbling. In women, retention is not by any means so common as in men, but the bladder will sometimes attain an enormous size, rising as high as the umbilicus; and such large bladders have been tapped under the supposition of the tumour being an ovarian cyst, or some similar growth. I once witnessed such a case in which the Surgeon, to his surprise, on tapping the tumour, drew off a quantity of clear and healthy urine, instead of ovarian fluid; fortunately no bad effects followed. This retention with dribbling occurs in consequence of the bladder, as it rises out of the pelvis, elongating its neck ; and as the body becomes bent forward over the pubes a sharp curve or angle is formed at the junction of the neck and body of the viscus, through which a small stream of urine continues to dribble away, and escapes rather by its own gravity than by any expulsive effort on the part of the patient.

Diagnosis.—Retention from *Atony* can easily be diagnosed from retention from *Obstruction.* In the former, on introducing the catheter when the patient is lying on his back, the instrument will not only readily enter, but the urine will simply flow out in a slow uniform stream, not being projected in a jet by the contraction of the walls of the organ, but rising and falling in obedience to the respiratory movements, or to the contractions of the abdominal muscles. In retention from obstruction, there will be experienced some difficulty in passing the instrument at some one point, either in the urethra or prostate; and when once it is introduced into the bladder, the urine will escape in a free and far projected stream.

Results.—The habitual retention of a small quantity of urine in an atonic bladder which is incapable of discharging completely the whole of its contents occurs much more frequently than is suspected. The quantity thus retained will vary from an ounce to half a pint: the patient believing that he has emptied his bladder. The existence of this residual urine is readily determined by telling the patient to try to empty his bladder. He thinks he has done so, but the introduction of a catheter will prove the existence of retained urine. This condition will be a source of serious inconvenience, and eventually of disease, to the patient. In consequence of the bladder never being completely emptied, there will be frequent, sudden, and almost irresistible calls to pass urine, so as to simulate irritability of the bladder. The retained urine becomes offensive, ammoniacal or fishy in odour, and mixed with mucus or muco-pus. The constituents of the urine become re-absorbed or are not excreted, derange the health, give rise to impaired nutrition, and, being eliminated by the skin, irritate it and occasion intractable forms of skin-disease. I have seen chronic eczema of the most inveterate character produced in this way, and yield to treatment only on care being taken to keep the bladder clear and free from residual urine.

The effects of retained urine and of retention are not identical. In retained urine the general health suffers, the patient becoming slowly poisoned by the inability to get rid of an excretion. In retention the danger is more immediate and directly dependent on the liability to secondary disease of the bladder and kidneys. Subacute cystitis, followed by low fever, will come on as the result of the continued over-distension of the bladder. The symptoms are such as are described at p. 966 as being indicative of urinary fever. The patient suffers from chills and small rigors, followed by depression and low spirits. Fever of a typhoid type comes on, with brown tongue, occasional retchings, mild delirium, and great prostration of strength. This condition occurring in an aged man long suffering from atony of the bladder, with most probably an unsound state of the kidneys secondary to this, is commonly fatal. It is thus that chronic retention from bladder-atony destroys life, not by ulceration of the organ or by extravasation of urine, which does not occur in these cases as in other forms of more acute retention.

Treatment.—Atony of the bladder, except in the few cases that arise from a single over-distension, is an incurable affection. It is dependent upon senile changes in the viscus of an organic character that may be relieved but cannot be remedied. The great danger in this state arises from the retained urine, even though retention be by no means complete. So long as this residual urine is in small quantity no harm results. Even when it accumulates so as to amount to several ounces, it may give rise to no symptom beyond frequency of micturition. Sooner or later, however, the over-distension causes some irritation of the bladder, and the urine becomes cloudy from excess of mucus. Decomposition of the retained urine then frequently takes place, either from extension of decomposition down the urethra or after the passage of instruments, as already described. It must not be supposed that mere retention of a small quantity of urine after each act of micturition is sufficient in itself to cause decomposition. Nothing is more common than to find patients who have not emptied their bladders for many months, and yet whose urine is perfectly normal in every respect. The statement sometimes made that decomposition never takes place till after an instrument has been passed, is, however, not accurate, although in the great majority of cases the urine becomes ammoniacal only after surgical interference. When this takes place all the symptoms of chronic or subacute cystitis set in. Febrile disturbance of the type of chronic septic poisoning sets in, and death may follow. This is more especially likely to happen when the kidneys are affected by chronic interstitial nephritis, which, as already pointed out (p. 957), is a common result of prolonged over-distension of the bladder.

The primary object of all treatment in ordinary uncomplicated senile atony of the bladder is to free the patient from the residual urine, which he is no longer able to expel. This can be done only by the use of the catheter, and it is the duty of the Surgeon to teach the patient how to use this instrument for himself, so that at all times he may be the master of his own situation, and relieve himself when necessary.

The commencement of "catheter-life," as it has been appropriately termed by Sir Andrew Clark, is an important period in a man's existence. For when once the use of the instrument has been begun, it can rarely be discontinued. Hence it is well not to begin it unnecessarily early. But it is of at least equal importance not to fall into the opposite error of delaying its use too long, lest the residual urine be allowed to accumulate to such an extent as to become a source of discomfort to the patient, of injury to his general health, and of danger by inducing septic cystitis and all its concomitant evils.

The use of the catheter in cases of atony of the bladder for the removal of residual urine is a very simple business, and, if the kidneys be sound and the most ordinary precautions taken, is unattended by any danger. The safest catheter to use is a soft one. The simple soft red rubber catheter will often pass with ease, and is then by far the best instrument to use. Metallic instruments need not be used by the Surgeon, and should never be employed by the patient himself. The ordinary elbowed prostatic catheter, or the conical one with a bulbous end of medium size, will be found most convenient if the rubber instrument will not pass. This should be passed whilst the patient is standing up, with every possible care and gentleness. The instrument should be lubricated with an antiseptic oil. After and before use the instrument must be washed in cold carbolized water, so that all chance may be avoided of fermentative material being carried into the bladder, and thus leading to putrefaction of the urine. At first it may be quite sufficient if the residual urine is drawn off every third or second day. After a time this will be required once or twice daily. Until the patient becomes accustomed to the use of the catheter all unnecessary exertion, fatigue, and, above all, chills, should be most carefully avoided. When once the habit has been established, these precautions may be relaxed, *provided there is no evidence of renal disease*, and the urine continues clear and healthy.

The catheter must not be retained, lest it occasion subacute cystitis. If, as often happens in senile atony, the prostate is somewhat enlarged, care must be taken that the catheter really enters the bladder, and that the dilated prostatic urethra be not alone emptied. The weight of the residual urine causes the fundus of the bladder to pouch behind the prostate. This pouch must be thoroughly emptied by slowly withdrawing the catheter when the body of the bladder has been drained. Should subacute cystitis come on, with decomposition of urine, during the treatment, the bladder must be washed out after being emptied, with antiseptic lotions of the permanganate of potash, quinine, or iodoform.

When once a bladder has become atonic in advanced age, it never completely recovers its contractility. The regular use of the catheter becomes imperative, and, by taking off the habit of retention and of overloading of the bladder, it may do much to restore the normal contractility, in some degree at least. When once fairly established, "catheter-life" may continue for many years without discomfort or appreciable danger.

No medicines are of any special service in these cases. The general health must be attended to on ordinary principles; and it must not be forgotten that one great difficulty and source of disease in advancing years is for the system to rid itself of its excreta—to clear away its own ashes—from organs and tissues, and that the residual urine found in an atonic bladder is but one, though possibly the most obvious evidence of this lack of power.

The treatment of that form of atony of the bladder, which arises in younger subjects, as the effect of gonorrhœal cystitis or stone in the bladder, consists in the daily use of the catheter with the same precautions that are to be adopted in cases of senile atony. Nux vomica may possibly be of use in some cases. Whenever the urine becomes turbid or offensive, antiseptic injections must be used to clear the bladder. All this the patient may, in most cases, be readily taught to do for himself. When once he has acquired the art of auto-catheterism, he may pursue the ordinary business of life with comfort and without peril. But he must never relax his care of himself, lest subacute cystitis may come on, or phosphatic deposits form in the bladder.

Incontinence of Urine.—This term is usually applied to all cases in which the urine is passed involuntarily. It occurs in three forms:—1. Passive incontinence in which the urine dribbles away as fast as it is secreted, the bladder remaining empty. 2. Distension of the bladder with overflow. 3. Active incontinence, in which the bladder is emptied involuntarily at short intervals by its own contraction.

Passive Incontinence arises most commonly from paralysis of the neck of the bladder, from disease or injury of the spinal cord. It is occasionally met with in children from causes that are not clearly ascertained. Civiale states that it has been known to arise from impaction of a calculus in the neck of the bladder in such a way as to prevent its closing, and yet to leave sufficient room for the urine to pass. Very rare cases have been recorded occurring in later life in which it was due to enlargement of the lateral lobes of the prostate, with a middle lobe situated between them in such a way as to keep them apart, and yet not to block the passage from the bladder. In tubercular disease of the prostate, with extensive destruction of the gland, complete incontinence may occur. Passive incontinence is occasionally met with in women, as the result of dilatation of the urethra for the removal of stone.

2. **Distension of the Bladder with Overflow,** as it is termed by Thompson, may be due to atony of the bladder (p. 1092), or to enlargement of the middle lobe of the prostate. The effects of atony in causing overflow of urine have already been described; overflow from prostatic disease will be described subsequently. It is of the utmost importance that this condition should be distinguished from true incontinence.

3. **Active Incontinence** is met with most frequently in children, and is, as a rule, not constant, occurring only at night. It occurs almost exclusively in boys. It seems to arise in some cases from the patient losing command over the sphincter during sleep, as soon as a small quantity of urine has accumulated behind it. This troublesome condition may last to adult life, and is a source of great misery and discomfort. In children it is in many cases sympathetic, being dependent on the irritation of a tight foreskin, of worms in the rectum, or of a polypus. In other cases it may be merely a symptom of stone in the bladder. In strumous children, nocturnal incontinence may be produced by the irritation of urine containing uric acid crystals. All these conditions must be carefully sought for in every case, and removed if possible.

Treatment.—In true incontinence little can be done beyond providing the patient with a proper india-rubber urinal, which can be worn day and night. The treatment of overflow consists solely in the periodical use of the catheter (p. 1094). In nocturnal incontinence of children, if it be not connected with some evident source of local irritation, which should then be removed, the administration of tonics will be found useful—either quinine or the tincture of perchloride of iron, alone or conjoined with tincture of cantharides. If there be irritation of the mucous membrane of the bladder, the administration of alkalies, in conjunction with a tonic, as the potassio-tartrate of iron, or a little copaiba mixed with honey, will be found very serviceable. Cold sponging, light clothing at night, and means calculated to break the habit, such as waking the child at the time at which it generally occurs, changing his position in bed, &c., should not be omitted. Of all remedies for incontinence of urine in children, belladonna is the most successful. Ringer advises it to be given in full doses; from 10 to 20 minims of the tincture three times a day.

Hysterical Retention and Incontinence of Urine not unfrequently occur in nervous girls, and require to be treated by anti-hysterical remedies, amongst which preparations of perchloride of iron, either alone or with valerian, will be found most useful. Cold douches are also of great service. In cases of hysterical retention, it may sometimes be necessary to use the catheter; but in such circumstances it is well not to employ this instrument too frequently, as the patients are apt to get into the habit of having it introduced, and will, with that morbid propensity that characterizes hysteria, continue for a length of time to require its introduction. If left to themselves, though the bladder may become much distended, it will not burst, but will probably empty itself without further trouble, particularly if the patient be put into a tub and well douched over the hips and loins with cold water. In some cases, these morbid conditions in women appear to be connected with some local irritation about the urethra or uterus ; and then proper treatment must be directed to these organs before the disease can be removed.

Painful Conditions of the Bladder.—The bladder may be the seat of severe pain, either continuous or remittent, without any disease being discernible in it on the closest examination ; the pain being either a kind of neuralgic condition, especially occurring in hysterical or hypochondriacal patients ; or else being sympathetic with, and dependent on, disease at a distance, as in the kidneys, uterus, rectum, &c. At the same time it must be borne in mind, that the secretion of acid or irritating urine will, in some individuals, be a source of much and constant suffering ; and that any disease seated about, or coming into contact with, the neck of the bladder, as tumour, stone, &c., is especially apt to give rise to severe suffering, and will, in many cases, be accompanied by frequent desire to micturate, with much spasm about the part.

TUBERCLE OF THE BLADDER.

Tubercular Disease of the bladder appears to be very rarely primary. It is usually an extension from similar disease of the kidney and ureter, or of the prostate. The bladder usually presents the ordinary appearances of chronic cystitis ; but, in addition to these, ulcers are found slightly raised at the edge, having a yellow granular surface, and situate exclusively near the trigone. The symptoms are merely those of chronic cystitis, and often closely resemble those arising from stone. If the trigone is affected there is great frequency of micturition, with severe pain before and after the act. The urine contains pus, usually abundantly. The diagnosis can be made only by the co-existence of tubercular disease elsewhere, more especially in the kidneys, prostate and testicles. Little can be done in the way of treatment beyond washing out the bladder to diminish pain and the irritation as far as possible. The injection of iodoform in an emulsion may be of use. Morphia-injections may give great relief.

SACCULI OF THE BLADDER.

Sacculi have already been mentioned at pp. 957, 999, and 1084, as arising in connection with over-distension of the bladder or obstruction to the escape of urine from it. These are of small size, not usually exceeding a pigeon's egg. They arise, as already described, in the bladders of elderly men who have suffered from severe mechanical obstacles to the passage of the urine, in the shape of stricture or enlarged prostate, are associated with a generally thickened fasciculated state of the organ, and appear to be the result of pressure on the contained urine during efforts at expulsion, causing extrusion of the mucous and serous coats, and perhaps of the thinned muscular coat at some points of least resistance.

Sacs connected with the bladder are, however, occasionally met with, the origin of which can hardly be explained in this way. These may be single or multiple, and may attain an enormous magnitude. The largest I have seen occurred in a man 35 years of age, otherwise perfectly healthy. He was admitted into University College Hospital, and was under the joint care of Wilson Fox and myself. There was a tense elastic tumour, smooth and rounded, occupying the whole abdomen and extending into the pelvis, so as to be felt through the rectum. Had it occurred in a woman, the disease would probably have been pronounced ovarian. The tumour had existed for six months, had gradually increased, but occasioned no uneasiness except by its pressure-effects. There was and had been no difficulty in passing urine or in defecation. The tumour was aspirated at its most prominent part, and seven pints of clear urine were drawn off. The patient suddenly became faint, and died of syncope. On examination after death, two enormous sacs were found connected with the bladder, one on each side, by a rounded opening that would admit the little finger. These orifices were equidistant from the mesial line, and about an inch and a half above each ureter. The sacs were thin-walled, composed chiefly of mucous membrane and peritoneum, possibly having scattered muscular fibres in their composition ; both were emptied through the bladder by the one puncture. The ureter on each side was adherent to the wall of the sacculus and considerably pressed upon, and as the result of this the pelves of the kidneys were dilated ; the pyramidal portion of the kidney was absorbed and the cortex greatly thickened and indurated by chronic interstitial inflammation. The bladder was greatly dilated and hypertrophied, its mucous membrane was opaque and white, and showed no signs of old or recent cystitis. The prostate and urethra were healthy, and no source of mechanical obstruction was detected. The cause of the condition is extremely obscure. There is a similar specimen, but somewhat less marked in the museum of University College ; the sacculus springs from the same spot, which indeed, from comparison with other specimens, seems to be the common point of origin of all sacculi of the bladder which reach any considerable size.

TUMOURS OF THE BLADDER.

Various forms of tumour, both malignant and simple, are met with in the bladder. The most common simple growth is the **Villous Tumour or Papilloma.** It consists of delicate branched processes which, when the growth is immersed in water float out, so that it somewhat resembles a sea anemone. These may spring from a narrow base forming a pedunculated mass, or spread over a considerable area of the bladder wall. The base from which they arise may be almost level with the surface of the bladder, or may form a fleshy mass of some thickness. Microscopic examination shows that each papilla is composed of a fine capillary loop, surrounded by an extremely delicate connective tissue, in some parts almost homogeneous, with numerous rounded or spindle-shaped cells scattered through it. The surface is covered with epithelium of the same character as that of the bladder but more delicate. The cells are often oval or fusiform, and are arranged in several layers. This delicate epithelium separates almost immediately if the growth is put in water, and is consequently often lost in microscopic specimens. The base is composed of loose and highly vascular connective tissue. These tumours almost invariably spring from some part of the trigone, usually near the orifice of one ureter or the meatus internus. They are usually single, but occasionally two or more are found.

Sir Henry Thompson states that only about one in six or seven are distinctly pedunculated, the great majority being more or less sessile. When pedunculated, the pedicle may, in rare cases, be of considerable length, sometimes an inch or more.

Other simple tumours are occasionally met with. Thus in children **simple mucous polypi** have been observed. They are smooth or nearly smooth on the surface, and composed chiefly of myxoma-tissue, similar to that seen in the simple polypus of the nose. In others the connective tissue basis of the tumour was so firm and the papillation on the surface so imperfect that the growth has been described as a **fibroma.** Probably all these growths are closely related to each other, consisting essentially of an out-growth from the submucous tissue of the bladder. **Myomata** also, or tumours containing non-striated muscular fibre have been met with springing from the wall of the bladder.

Sarcoma of the bladder is less frequent than the simple growths, but is not uncommon. The growth is composed of round cells, or mixed round and spindle cells, and is papillary on the surface. The distinction between this and a papilloma with a thick base which has been inflamed is not easy to make out, and further investigation is required before a clear separation can be made between these tumours ; more especially as all new growths in the bladder, whether simple or malignant, tend to assume a papillary form. Sir Henry Thompson describes tumours which, in his opinion, occupy a place between papilloma and sarcoma, and which he terms "transitional." One tumour removed by him was found to be a chondrifying sarcoma.

Symptoms.—Simple tumours of the bladder occur usually in youth or early middle age. The earliest symptom in all forms of simple tumour is hæmorrhage. At first it is small in amount and intermittent, but as the disease progresses it becomes more abundant and almost constant. The characteristic sign of hæmorrhage from a villous tumour is that the blood is not uniformly mixed with the urine, but comes chiefly towards the end of micturition, sometimes dropping away almost pure after the urine has ceased to flow. The quantity may be very large, and clots are often passed. As the disease advances frequency of micturition and the general signs of irritability of the bladder may make their appearance, but hæmaturia may form the only symptom for many months or even years. I have known abundant hæmaturia to continue for many years—for twelve or fourteen—probably from a papilloma, without deranging the general health to so great an extent as might be expected from so continuous and copious a loss of blood. The most important sign, and one which should always be persistently sought for, is the passage of recognizable fragments of the growth in the urine. But little information is gained by sounding ; occasionally some irregularity may be felt, but its nature and outline cannot be determined. A hollow sound may, however, return with some of the growth in its eye, and thus determine the nature of the case. Profuse hæmorrhage, after sounding, commonly occurs, but is not sufficient to found a diagnosis upon. Examination of the trigone from the rectum never gives any information unless the tumour be very large, when it might possibly be recognized by pressing firmly above the pubes at the same time. Careful examination of the bladder by means of a small flat-bladed lithotrite may detect the presence of the tumour, as in the first case recorded by Thompson.

These tumours occasionally become encrusted with *phosphatic* matter, deposited upon them by the urine, and then they will resemble still more closely a calculus when the bladder is sounded; from it, however, they may be distinguished by their fixed character, and by the impossibility of passing a sound around them.

If the disease be left unrelieved it terminates fatally sooner or later, sometimes by exhaustion from constant loss of blood, but more often by disease of the kidneys induced by the obstruction to the orifices of the ureters by the growth, or by septic cystitis extending to the pelvis of the kidney.

The **Diagnosis** can usually be made by attention to the above points; but should this not be possible, the bladder may be explored in the following manner as practised by Sir Henry Thompson, the exploration being followed, if possible, by removal of the growth, should it seem suited for such treatment. An ordinary curved median staff is first passed into the bladder, and the patient is tied up in the lithotomy position. The Surgeon then introduces his left forefinger into the rectum and feels for the apex of the prostate. He then takes a long narrow-bladed straight bistoury, and makes an incision about one inch and a quarter long in the middle line of the perinæum, terminating about three-quarters of an inch from the margin of the anus. The knife is then turned with its back to the rectum and entered near the lower end of the superficial incision. Guided by the finger in the rectum, the knife is then pushed steadily on till it enters the groove of the staff near the apex of the prostate. By drawing it forwards in the groove the membranous part of the urethra is opened. The knife may now be withdrawn, cutting slightly forwards in so doing, care being taken not to wound the bulb more than can possibly be avoided. Sir H. Thompson then introduces a blunt gorget-like director with a beak to run in the groove. An ordinary long steel director, or a long probe, may be used instead if this instrument be not at hand. The staff being withdrawn, the finger is gently pushed along the director into the bladder. The operation is, in fact, nothing more than the ordinary median operation for lithotomy as performed by Allarton. The patient must at this time be brought to a condition of thorough muscular relaxation under the anæsthetic. The Surgeon standing up presses on the bladder from above the pubes with his left hand, while he systematically examines every part of its walls. This method of examining the bladder is impracticable in very fat subjects and in cases of great enlargement of the prostate. The latter obstacle would, of course, be ascertained by examination through the rectum. In such cases if the bladder is examined at all it must be by suprapubic cystotomy. Should a papilloma be found, the exploratory incision will serve for its removal. Should there be no papilloma, the method of examination will determine the condition of the interior of the bladder, the presence or not of malignant disease, or of encysted calculus, and if none of these are present, will serve as an opening through which drainage may be maintained for a few days in the hope of relieving the irritability or chronic inflammation from which the patient is suffering.

In females the bladder is easily explored by dilatation of the urethra and introduction of the forefinger, a proceeding which, as a rule, is not even followed by incontinence of urine.

The **Treatment** of simple tumours of the bladder was up to a recent period of the most unsatisfactory character, Surgeons usually contenting themselves with attempting to restrain the hæmorrhage by means of gallic acid and similar astringents. Operative means were seldom employed. It is true that Civiale removed a small growth situated near the neck of the bladder by seizing and twisting it off with a lithotrite. Warner removed a tumour of this kind the size of an egg from the bladder of a woman after dilating the urethra. Billroth removed a tumour from the bladder of a boy which proved to be in parts a myo-sarcoma, in others a myo-carcinoma. It was as large as the fist, and had a pedicle which appeared to be connected with the muscular coat. The operation consisted of cystotomy by the ordinary lateral operation. But as the tumour was too large to be got away through the perinæum, the bladder was opened above the pubes by a free transverse cut. The tumour was then torn away by the finger, and the pedicle cut across with a knife guarded by the finger. The patient did well. Humphry in 1877 operated on a boy who had a tumour in the bladder causing dysuria and hæmorrhage. He opened the bladder by lateral cystotomy through the perinæum, and removed the tumour with forceps and the finger-nail. It proved to be a fibro-sarcoma. The patient made a good recovery. Volkmann and Marcacci both performed suprapubic cystotomy for the removal of vesical myomata, but with fatal results. In 1881, Ransvhoff of Ohio, removed a tumour as large as a small peach growing from the posterior wall of the bladder. The operation he practised was lateral cystotomy; the tumour was then scraped away by means of one of Volkmann's sharp spoons. The patient recovered after a tedious convalescence.

To Sir Henry Thompson is due the merit of having placed the operation on a more definite basis. His operation consists in opening the urethra and inserting his finger as above described, feeling for the tumour, and then removing it by forceps specially designed by himself, by which it is seized and crushed or torn away from the mucous membrane. His earlier operations were all performed in this way, a perinæal incision only being made, but increasing experience has convinced him that this method is only adapted to the simple pedunculated growths of very moderate size. If the digital exploration shows a tumour of some size, he immediately performs suprapubic cystotomy, pushing the bladder up with a large sound passed through the wound. The fact that all but the simplest growths require suprapubic cystotomy for their removal, would suggest that in those cases in which the diagnosis of tumour is certain, the perineal incision is a needless complication, and S. Jones, Bennett May, in this country, and von Bergmann, Guyon, Dittel, and others on the Continent, have advocated and successfully practised the immediate performance of the high operation. Even for small pedunculated growths this operation is probably safer for those whose experience is limited, as in it the forceps can be guided by sight and touch, whereas by the perinæal method it is more or less of a snatch in the dark. Increasing experience has moreover shown that the suprapubic incision is little if at all more dangerous than the perinæal.

In removing tumours by the suprapubic method the bladder is opened in the same way as in the high operation for stone. Each side of the incision in the bladder must be held well up by tenacula, or, better, by a stitch passed through the coats. The cavity must then be gently cleaned, either with a small piece of sponge, or by running a stream of boracic lotion through it. Great gentleness must be used in doing this, as if the tumour be made to bleed it is practically impossible to see anything. If, however, the bladder can be cleaned without hæmorrhage, its cavity may be illuminated by means of a lamp and mirror, or, better still, by a small incandescent electric lamp passed into it. As a rule, however, the blood obscures everything, and the Surgeon must be guided by feeling the growth. It may be removed by Thompson's forceps, or by an écraseur. In some cases the galvanic écraseur has been used. If scissors are used the bleeding is very free. If the growth is sessile and widely diffused it may be scraped away with a sharp spoon, but this is hardly likely to produce any lasting benefit, except in those rare cases of diffuse simple papillary growths, scarcely deserving the name of tumours. If the bleeding is very severe it may be arrested by pressure with a sponge, or by cold, or hot water. Strong chemical styptics should be avoided, as they may cause serious cystitis.

The after-treatment of the case is the same as in suprapubic lithotomy.

Further experience is still required before the best method of removing tumours of the bladder can be finally determined. The perinæal incision is doubtless the easier and probably the less dangerous method of getting to the tumour, but the suprapubic affords much greater facilities for removing it and has the great advantage of making it possible to apply direct means for arresting hæmorrhage if necessary.

In the female, dilatation of the urethra is so simple a proceeding that it should always be done before any further operation is undertaken.

The results of the removal of simple villous tumours of the bladder have been on the whole very satisfactory. In all other forms of tumour recurrence has very frequently occurred. The operation has been directly fatal in a small proportion of cases.

Cancer of the Bladder.—The bladder is not a common seat of primary cancer ; it is more often implicated by the extension of malignant disease from some neighbouring part, as the rectum or uterus. According to Walshe, it never appears before the fortieth year. The form of cancer occurring in the bladder as a primary disease is squamous epithelioma. Scirrhus is said to have been met with, but most probably it commenced in the prostate and not in the bladder itself. Epithelioma of the bladder often commences on the posterior surface, extending secondarily to the trigone. The ulcerating surface of the tumour occasionally becomes encrusted with phosphatic deposit, and sometimes a phosphatic calculus may form in the diseased bladder, and thus add greatly to the intense pain that usually attends this affection. The **Symptoms** it gives rise to are intense dysuria, with discharge of blood, and viscid mucus, in which fragments of the tumour may be found. No conclusion of any kind can be drawn from single cells ; it is only when a distinct group of cells is found, possibly attached to a portion of stroma, that any opinion can be formed as to their source. In a case under the care of Berkeley Hill, the nest-like arrangement of the epithelial cells was recognized in some fragments passed in the urine. Sir H. Thompson states that the diagnosis of cancer from simple tumours may be made by the age of the patient, and by the fact that pain and frequency of micturition appear early, often before the blood. In simple tumours, blood is the first symptom, preceding pain, often by many months. The rapid progress of the disease, and the intensity of the patient's sufferings, differ widely from the slow progress and slight discomfort caused by simple tumours during the early period of their development. Cancer of the bladder frequently causes a tumour which can be felt from the rectum ; simple tumours practically never do and for this reason Sir Henry Thompson lays down the law that if the tumour can be felt from the rectum it is not a case to operate on except for the purpose of relieving suffering by perinæal drainage.

When secondary to rectal cancer, a communication will usually have been established between the two cavities through which flatus and fæces pass into the bladder, and thus greatly aggravate the patient's sufferings.

The **Treatment** of cancer of the bladder must necessarily be merely palliative in all but a few exceptional cases. Morphia hypodermically administered, the frequent use of the catheter, with disinfectant injections, possibly drainage of the bladder through a median perineal section, and, in those cases that are secondary to rectal cancer, colotomy, constitute the main elements of the treatment. The possibility of removing a portion of the wall of the bladder has, however, been demonstrated by numerous experiments on animals, and by operations on the human subject. In 1885, Sonnenburg, of Berlin, removed two-thirds of the bladder wall, opening the peritoneum in so doing. He sutured the peritoneum accurately, but was unable to close the walls of the bladder, and yet the woman survived one month, dying of exhaustion. In the same year, Antal, of Buda Pesth, successfully removed about one-third of the bladder without wounding the peritoneum, which had to be stripped off part of the portion removed. Such proceedings can, however, rarely be possible.

HÆMATURIA.

The admixture of blood with the urine may usually be recognized by the colour which it communicates to this fluid. If the blood be in large quantity, the urine will be dark brown, chocolate, or maroon-coloured, and will stain red the bottom of the utensil or a piece of white blotting-paper. If it be in smaller quantity, the urine will be brown in varying shades—smoky, or having something of the aspect of thin beef-tea ; in other cases it will be little discoloured, but will deposit a red or brown sediment on standing. Under the microscope, blood-discs may be detected in large numbers. Heat coagulates the blood into a brownish-grey deposit, leaving a clear supernatant fluid. Microscopic examination should never be neglected in doubtful cases, as by that means small traces of blood may be certainly recognized ; and, moreover it must be remembered that in the condition known as hæmatinuria the urine is darkly stained with blood-pigment, but contains no corpuscles. The patient's word that he has passed blood should never be relied upon too implicitly, as high-coloured urine depositing uric acid or urates is often ignorantly supposed to contain blood.

Hæmaturia may arise from a *constitutional* condition or from a *local* cause. When *constitutional*, it may be the consequence of scurvy or purpura. In these cases it will necessarily be associated with other, and probably marked, evidences of the disease. A form of hæmaturia, depending on the presence of a parasite—the *Bilharzia hæmatobia*—is prevalent in Africa, and has been ably investigated by Leuckart, John Harley, Cobbold, and others.

When arising from *local* causes, hæmaturia is a symptom of disease existing in some part of the urinary apparatus, and it often assumes great importance from the loss of blood induced.

Sources.—Hæmaturia may arise from, 1, the Kidneys ; 2, the Bladder ;

3, the Prostate; or 4, the Urethra; and from each source several distinct causes will produce it.

1. **Hæmorrhage from the Kidneys.**—When occurring from the kidneys, the bleeding may be the result of congestion, acute inflammation, or malignant disease of those organs; of acute, tubercular, or calculous pyelitis; or of passage of a calculus down the ureter. The most certain evidence that the blood comes from the kidney is the presence of blood-casts of the renal tubules. The renal congestion may be inflammatory or passive; in either case the urine will present, after the discharge of blood has ceased, evidences of chronic renal disease in the form of albumen, pus, or casts of tubes. When the hæmorrhage arises from renal calculus, either stationary or descending, the symptoms of that morbid condition, described at p. 971, Vol. II., will be well marked. Blood from the kidney does not often appear as clots, and is uniformly mixed with the urine. Blood-casts of the ureter have been seen in cases of very profuse renal hæmorrhage from cancer or injury.

2. **Hæmorrhage from the Bladder.**—If the blood proceed from the bladder, it may be the result of congestion of the mucous membrane, of the irritation of a calculus, of a papilloma or other villous tumour, or of the ulceration of malignant disease. When it depends on vesical congestion, there will be a sensation of weight in the region of the bladder, with frequent desire to pass urine; when on calculus, the special symptoms of the existence of stone will be present. When it occurs from a villous tumour at the neck of the bladder, the quantity of blood lost is usually very great and the hæmorrhage persistent. If it arise from malignant disease, the discharge of pus, and of the *débris* of the ulcerating tumour, may afford evidence of the source of the hæmorrhage. Blood from the bladder usually is most abundant towards the end of micturition, especially in cases of tumour, the first urine that passes, or that is drawn off by a catheter, being pale and less bloody than the last, and at the termination nothing but blood may flow. In stone and cystitis it is more often uniformly mixed with the urine. Irregular masses of clot are often passed when the hæmorrhage has been very abundant.

3. **Hæmorrhage from the Prostate.**—If the prostate be the source of hæmorrhage, the discharge may be occasioned by congestion of that organ, or by its ulceration, simple or malignant. In these cases, exploration by the rectum and urethra will indicate the true cause of the bleeding. The blood usually finds its way back into the bladder rather than towards the penile urethra, and thus may appear towards the end of micturition, or be uniformly mixed with the urine.

4. **Hæmorrhage from the Urethra.**—The bleeding may arise from simple congestion of the mucous membrane, from inflammatory irritation of it, or may follow rupture of the walls of the canal, consequent on injury or on the introduction of instruments. Blood from the urethra usually flows independently of micturition, as in recent injuries, or passes with the first few drops of urine. It may, however, occasionally come with the last drops expelled. This is by no means uncommon in gonorrhœa, or in cases of gleet dependent upon a granular condition of the mucous membrane of the bulbous portion of the urethra. It seems, then, to be due to the contraction of the ejaculator urinæ squeezing a drop or two of blood from the inflamed spot.

Treatment.—The treatment of hæmaturia must necessarily have reference to its cause. When it depends on a morbid constitutional state, as scurvy or malarial poisoning, the treatment of the disease, of which the hæmaturia is merely a symptom or an effect, must be conducted on ordinary medical principles. If it arise from inflammatory congestion of the kidneys, bladder, or prostate, cupping, or the application of leeches over the affected part, demulcents, and saline drinks, will be most efficacious ; if from passive congestion, saline purgatives, followed by the use of astringents, will speedily induce a cessation of the hæmorrhage. The astringent that exercises the most marked influence in arresting hæmaturia, when that condition is purely passive, is undoubtedly gallic acid. This may be given in five or ten grain doses, frequently repeated, in infusion of buchu or uva ursi.

Sometimes the bladder becomes distended by a large soft coagulum, filling up its interior, and causing it to reach to the umbilicus, forming a rounded solid tumour, like a gravid uterus. In such circumstances, the largest catheter that can be introduced must be passed, and the syringe of an aspirator adapted to it. By this means the blood, even when coagulated into a single large clot filling the whole bladder, may be easily removed, and thus a complication formerly most troublesome to the Surgeon and agonizing to the patient is overcome without the slightest difficulty. The evacuator used in lithotrity would answer the purpose equally well. If these instruments be not at hand, the fluid contents of the bladder must be drawn off by a large catheter, and the more solid portions broken down and washed away by the injection of one of the antiseptic solutions recommended for cleaning the bladder in chronic cystitis (p. 1086). Should decomposition occur, the bladder must be frequently washed out with antiseptic fluids.

CHAPTER LXXI.

DISEASES OF THE PROSTATE.

THE prostate is subject to Acute and Chronic Inflammation, to Hypertrophy, and occasionally to Atrophy, Malignant Disease, Tubercle, and the formation of Calculi.

PROSTATITIS.

Acute Inflammation of the Prostate, or Prostatitis, very rarely occurs as an idiopathic affection. When met with, it is usually the result of gonorrhœa, or of the use of instruments, more especially in middle-aged men.

The **Symptoms** are, deeply-seated dull pain, with heat and weight in the perinæum, a frequent desire to pass urine, and very great and spasmodic pain accompanying the act ; in fact, the irritability of the neck of the bladder is perhaps the most distressing feature in the disease. These symptoms are, however, common to various inflammatory affections of the urinary organs, and they can be distinctly referred to the inflamed prostate only by rectal exploration. On introducing the finger into the gut, the prostate will be found much enlarged and exquisitely tender. The patient often suffers considerably from the pressure of the inflamed organ upon the rectum during defæcation.

The **Treatment** should be of an actively antiphlogistic character, so as to prevent, if possible, the formation of abscess. The perinæum must be well leeched ; warm hip-baths and poppy fomentations assiduously employed ; and salines administered. In this way, the formation of abscess within or around the prostate may, in many cases, be prevented. Morphia suppositories may be used to relieve pain.

Prostatic Abscess may form either as a consequence of acute inflammation running on to the suppurative stage, and in this way it is not very unfrequently met with as a complication of gonorrhœa ; or it may occur with comparatively little antecedent inflammation—as sometimes happens in pyæmia, or if the organ be accidentally bruised during lithotrity. In these cases, abscess perhaps as frequently forms in the areolar envelope as in the organ itself. Idiopathic suppuration of the prostate, irrespective of any of the above causes, is of rare occurrence ; but it may occur in individuals of broken health, the matter then usually accumulating in large quantity, and discharging itself into the bladder.

Symptoms.—When inflammation of the prostate terminates in abscess, rigors, with strangury, and perhaps retention of urine, occur. In many cases the perinæum becomes brawny ; in others, tenderness of the gland and deep fluctuation may be felt through the rectum. When left to itself, the abscess most usually gives way into the urethra or neck of the bladder ; but it may, especially when occurring in the prostatic capsule, open externally into the perinæum, or even into the rectum. In many cases, the abscess presenting on the urethral surface of the prostate is burst during the introduction of the catheter, used for the relief of retention of urine caused by the swelling; the matter escaping along the side of and through the instrument.

Treatment.—It not unfrequently happens that the first certain indication afforded to the Surgeon of the formation of a prostatic abscess is the escape of pus by the urethra, or mixed with the urine, so as to give this fluid a thick milky appearance. In such circumstances, the only available treatment is that for the relief of the strangury and local vesical irritation already described. But if, as sometimes happens, the pus come forward into the perinæum, and a hard brawny mass be felt lying deeply on the side of the perinæum, a deep incision should be made into this. The Surgeon must not wait for fluctuation, but must cut deeply in the direction of the matter, keeping, however, as nearly as possible in the middle line, with the back of the knife towards the rectum. Even if no pus escape at first, it may do so if the part be well fomented for a few hours; and thus communication with the urethra or rectum may be prevented. When the abscess points towards the rectum, and fluctuation can clearly be felt by the finger in the bowel, it may be opened in this situation. To do this, the bowels must first be thoroughly opened, and the rectum cleaned with an enema. The patient is then anæsthetized and tied up in the lithotomy position, the pelvis being well raised on a pillow. A duck-bill speculum is then passed, and the fluctuating spot explored with a good-sized aspirator needle. If pus is found, a scalpel may be pushed in; the opening is then dilated with a pair of polypus-forceps and a drainage-tube inserted. The tube falls out in a few hours, and need not be replaced, as the cavity usually closes rapidly as soon as the pus is let out. If the incision be limited, and kept as nearly as possible in the middle line, there is no hæmorrhage of any consequence.

Retention of Urine from Prostatitis.—In prostatitis retention may occur from swelling of the organ, from infiltration of exudation-matter around it, or from the formation of pus in it. If the symptoms are not urgent a morphia suppository should be administered, and the patient should be made to sit in a hot hip-bath and told to try to pass water while in the bath. If that fails an instrument must be passed. A soft red rubber catheter should first be tried. If that fails a soft elbowed catheter not smaller than No. 8 (English scale) should be tried. If soft instruments fail the Surgeon must fall back on silver catheters. In these cases the neck of the bladder may be carried to a considerable distance from the surface, and may then not be reached by an ordinary catheter, which may be buried up to the rings and yet not enter the cavity of that organ. In these circumstances a silver prostate-catheter should be employed; and this must be carefully introduced, lest, by entering the cavity of an abscess which has already burst *per urethram*, it might be supposed to have entered the bladder itself. In introducing the instrument, care should be taken to keep its point constantly in contact with the upper surface of the urethra, and to hook it round the pubes. The *upper* surface of the urethra is a sure guide to the bladder; for any abscess, false passage, or irregularity of direction will always first affect the lower aspect of this canal, being surrounded by yielding structures; whilst the upper part, being firmly supported by bone and ligament, cannot so readily alter its direction.

Chronic Inflammation of the Prostate may follow the acute affection, especially when it is gonorrhœal. The patient is troubled by a sense of weight and fulness in the perinæum, and there may be an occasional glairy discharge from the urethra; fine threads of mucus, the so-called "*prostatic threads*," may often be seen floating in the urine, especially in that first passed, and in the last few drops expelled by straining if these be collected separately. Frequency of micturition and some pain during and after the act may be present. Examination by the rectum shows that the prostate is slightly tender, hard, and enlarged, sometimes more on one side than the other. A chronic abscess may slowly form without great increase in the intensity of the symptoms. This complication, which is fortunately rare, is recognized by examination from the rectum. Should the abscess burst into the urethra, the cavity in the indurated gland-tissue may be very slow in healing. I have known a case in which, after many years, the prostate remained hard and enlarged, and on pressing firmly on it from the rectum, pus could be made to flow from the urethra. The patient was obliged to draw off his water with a catheter, but suffered very little in his general health.

The **Diagnosis** of this condition from tubercular disease is often extremely difficult. Its extremely chronic nature, the absence of any disease of the testicles or vesiculæ seminales, the more uniform enlargement of the gland, and the history of the case will usually determine its nature.

The **Treatment** consists in repeatedly blistering the perinæum. Belladonna suppositories may sometimes relieve the uncomfortable sensations. Any treatment by the urethra, such as injections of nitrate of silver, will only aggravate the condition. Tonics, change of air, and sea-bathing are sometimes of use. Iodide of potassium may be given, or the iodide of iron if the patient is anæmic. Should an abscess form and point towards the rectum or perinæum, it must be opened.

Prostatorrhœa has been described by Gross as a discharge of clear glairy mucus from the prostate, in consequence of irritation of that organ. The disease is characterized by the discharge of a few drops of ropy, viscid mucus from the urethra after micturition or defæcation. It is of importance chiefly from its liability to be confounded with spermatorrhœa, and from the depressing effect consequently produced upon the patient's mind.

The **Diagnosis** of prostatorrhœa from *spermatorrhœa* may be effected by microscopical examination of the characters of the discharge.

The **Treatment** consists in attention to the state of the general health; the administration of tonics, more especially of iron and nux vomica; the removal of any local source of irritation in the urethra, rectum, or anus, as stricture, piles, or fissure; and the local application to the prostatic portion of the urethra of the nitrate of silver. The application of a blister to the perinæum is beneficial in some cases.

Deep-seated and very Chronic Abscess will sometimes slowly form in the pelvis, between the bladder and rectum, behind the prostate, giving rise by its pressure to a long train of obscure symptoms, indicative of irritation about these organs, such as dysuria, strangury, and occasional admixture of pus with the urine. On careful examination of the perinæum and rectum, some slight hardness may perhaps be deeply felt in the mesial line, or towards one side of it. This slowly increases, and perineal abscess of an ill-defined character develops. When this has become sufficiently evident, a free incision should be made into it, when pus in greater or less abundance will escape. On careful exploration by a probe of the cavity thus opened up, a deep sinus will probably be found leading into the pelvis, and to the original seat of the abscess. This requires to be opened up by a free incision on one side or other of the perinæum, as if for lateral lithotomy, and a proper and direct exit given to the matter. The cavity must then be allowed to granulate from the bottom.

CHRONIC ENLARGEMENT OF THE PROSTATE.

Chronic Enlargement of the Prostate may be looked upon as a senile disease, seldom occurring before the age of fifty-five, but commonly met with after this. At that period of life, as Brodie observes, when the hair becomes grey and scanty, when the coats of the arteries begin to become atheromatous, and when the arcus senilis forms on the cornea, the prostate often becomes increased in size; but unless the enlargement interferes with the free escape of the urine, no disease can properly be said to exist. If we look upon the diseased enlargement of the prostate as such an amount of hypertrophy of this organ as interferes seriously with the discharge of the urine, we shall probably not find it so frequent even in old men as is generally supposed. Guthrie states that it is not commonly found in the pensioners at Greenwich Hospital. Thompson found that an enlargement appreciable after death existed in 34 per cent. of men above the age of sixty; but that such a degree of enlargement as to give rise to symptoms during life was met with only in 15 or 16 per cent. of the cases he examined. Though age must be looked upon as the primary cause of hypertrophy of the prostate, there can be little doubt that it may be predisposed to by any continued source of irritation of the urinary organs, such as gonorrhœa, stricture, or hard living.

Characters.—Enlargement of the prostate is due to hypertrophy of the normal structures—muscular, fibrous, and glandular—of the organ. Most commonly there is an excess of development of the muscular and fibrous structure; when, however, the size of the gland has been very slowly and not greatly enlarged, there is nearly equal hypertrophy of all the tissues. In rare instances, there is excessive development of the glandular element; and in some cases homologous tumours are developed. The enlargement generally occupies the whole of the organ, and may cause its size to increase to that of a hen's egg or a small orange. In most cases, all the lobes are enlarged equally or nearly so, but sometimes there is a disproportionate development of one of the lateral lobes or of the middle portion. More rarely, the lateral lobes or the anterior commissure alone are enlarged.

The enlarged prostate, in the earlier stages, presents to the naked eye an appearance of rotundity and increased fulness; at a more advanced stage, there may be great irregularity of outline. There is usually no change of colour externally, and the texture of the gland is generally indurated; though sometimes, when the glandular element is chiefly increased, it is found to be looser and softer than natural. On making a section, the cut surface bulges above the level; and the shades of colour are more strongly marked than in the healthy prostate. Not uncommonly, single gland-lobules are found hypertrophied; and in some cases, spheroidal prominences are seen, which are easily enucleated, and which are tumours formed in the substance of the gland. Of these we shall presently speak. In some instances, an abundance of fluid escapes from the cut surface and from the openings of the prostatic ducts; while in other cases this is entirely wanting. Small cavities, dilatations of the gland-follicles, are occasionally found; sometimes empty, sometimes containing a yellow fluid resembling pus in appearance, but consisting of the prostatic secretion in a thickened state. The prostate may attain a very large size. The largest that I have seen is certainly one in the Norwich Hospital Museum, taken from a man of eighty; it weighs more than 20 ounces.

Simple Prostatic Tumours.—The nature of simple tumours of the prostate has been carefully studied by Sir Henry Thompson; to whose elaborate work on the diseases of this organ the student is referred for further information. According to Thompson, tumours of non-malignant character are met with in most cases of hypertrophied prostate, and also occasionally when there is no enlargement of the organ. He divides them into two classes:

"1. Tumours which are generally imbedded in the substances of the prostate, but the structures of which are isolated from those which surrounded it.

"2. Outgrowths which are continuous in structure with the parts of the prostate whence they spring, but which manifest a tendency to become partially isolated, by assuming a more or less polypoid form, and maintaining attachment to the parent organ through the medium of a pedicle only."

1. The *isolated tumours* in the substance of the prostate have been recognized by Sir E. Home, Cruveilhier, Rokitansky, Paget, and other pathologists. They may occupy any portion of the organ; but are, perhaps, more numerous in the lateral lobes than elsewhere. They are easily enucleated, having but a loose connection with the substance of the gland. In diameter they vary from $\frac{1}{10}$th to $\frac{5}{8}$ths of an inch. They are firmer and mostly paler in colour than the proper prostatic tissue, and are less vascular.

"The basis of the tumours appears to be the fibrous basis or stroma of the prostate itself, an admixture of unstriped, soft, pale muscular fibres, and connective with a little elastic tissue, closely interwoven. Interspersed with this, there are present in most cases small cavities containing flattened polygonal or spheroidal epithelium, like that seen in a pouch at the extremity of a prostatic gland-duct, and sometimes, also, some prismatic epithelium. These cavities are sometimes solitary, sometimes slightly branched, and sometimes of an elongated or tubular form. In a few instances there is very little, or, perhaps no such glandular tissue to be found; generally, however, a careful search will discover it. In some of the outlying tumours the glandular structure is more perfectly developed—in some it is quite so—and a duct is furnished which evidently carries secretion to the appointed destination."

2. The part of the prostate which is most usually the seat of *outgrowth* is the middle or urethral portion, which may become greatly enlarged in size, with or without hypertrophy of the lateral lobes. The growth assumes a pyriform shape, and is more or less pedunculated. It is continuous in structure with the prostatic tissues, and has its own duct, which opens into the urethra through the pedicle. Prostatic concretions are commonly found in these outgrowths; never in the isolated tumours.

Though most common in the middle portion of the prostate, outgrowths may occur from the posterior part of one of the lateral lobes, or from that portion of the gland which lies above or in front of the inner orifice of the urethra.

In rare instances, the verumontanum alone appears to be affected, forming a thickened polypoid projection, which projects in a valvular manner, and interferes materially with the flow of urine.

Thompson points out that, as had been suggested by Velpeau, remarkable analogies exist between these prostatic outgrowths and the fibroid tumours of the uterus. This view is in accordance with the theory that the prostatic utricle is the analogue of the uterus.

Mechanical Effects of Enlarged Prostate on the Urinary Organs.—Enlargements of the prostate are productive of inconvenience with regard to the flow of urine, giving rise either to retention or to incontinence, or to a kind of mixture of both conditions. When the lateral lobes are enlarged, there is a diminution of the lateral or transverse diameter of the urethra, at the same time that the antero-posterior diameter is increased, so that the canal becomes a chink-like passage. The urethra also becomes greatly elongated and tortuous; and is diverted from the natural direction—this varying with the form of enlargement. When the median portion is enlarged, there is a more or less angular curvature of the canal at the prostatic portion. When, in addition, there is enlargement of a lateral lobe, the urethra is curved also laterally in the direction of the enlarged lobe. The lateral deviation may occur also when there is enlargement of the middle lobe: but it then affects both sides.

The inner orifice of the urethra also undergoes changes. Enlargement of the posterior part of the middle portion of the prostate gives it a crescentic form, with the convexity directed upwards; and, in enlargement of either lateral lobe, the convexity of the crescent lies towards the side opposite the enlarged lobe. Sometimes, when there are two or more irregularly enlarged lobes, the orifice is very much distorted, elongated, and tortuous. Sometimes, in cases of valvular or pedunculated projections from the posterior portions, the orifice appears to be overlapped altogether. This condition existed in the case from which the accompanying drawing (Fig. 938) was taken; the third, or median lobe forming a pedunculated tumour which acted like a valve—obstructing the exit of the urine from the bladder, though it did not offer any obstacle to the introduction of a catheter.

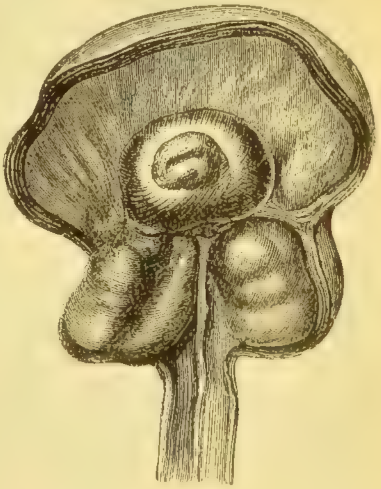


Fig. 938.—Bladder laid open, showing Enlargement of Urethral Portion of Prostate.

The elongation and expansion of the prostatic portion of the urethra gives rise to an increase in its capacity, so that it sometimes holds two or three ounces of urine; and the elongation will carry the neck of the bladder upwards and behind the pubes, to a considerable distance from its normal position.

While the lateral enlargements cause the urethra to assume a somewhat tortuous course, the middle lobe, if hypertrophied, may readily occasion retention, by projecting against the entrance to this winding channel, and falling over it like a valve whenever the patient attempts to pass urine, as in Fig. 939. In this condition no urine is passed until by accumulation within the bladder the neck has become so stretched that the valve-like obstruction no longer closes the orifice. Then a small quantity of urine is expelled; the neck of the bladder collapses, and before the cavity is completely emptied, the orifice is blocked by the projecting middle lobe, and the flow ceases. Thus a certain amount of urine is always retained, which is commonly termed the "residual urine," and none escapes till the bladder is in a state of considerable tension. As the middle lobe increases in size, a greater degree of stretching is necessary before urine can escape. Under this constant tension the bladder slowly yields and becomes dilated, its walls are thickened by fibroid tissue, and it gradually becomes completely "atonic," losing all active power of contraction. At last a condition is reached in which urine flows only when the bladder is greatly distended, and the escape of a few drops is sufficient to render the obstruction complete, and thus a condition of almost constant dribbling is established. This forms the most typical variety of prostatic obstruction. Less commonly, the obstacle to the passage of urine is of such a nature that it can be forced by increased pressure, and we then find the muscular coat of the bladder hypertrophied, as in stricture of the urethra. In still more rare cases the middle lobe lies between the enlarged lateral lobes, thus propping the neck of the bladder open, and then true incontinence may occur with constant dribbling of urine.

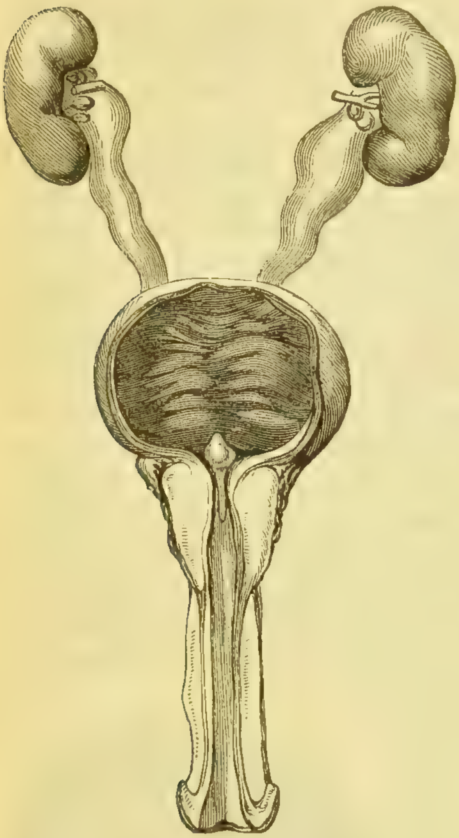


Fig. 939.—Results of enlarged Prostate: Bladder enlarged; Ureters dilated; Chronic Disease of Kidneys.

The effect on the kidney will vary according to circumstances. If the bladder is in a constant state of over-distension, a similar increased tension will occur in the ureters, as it is evident that increased force will be required to drive the urine through their orifices. We consequently find all the signs of increased tension already described (p. 959); dilated ureters and pelves, absorption of the pyramids, chronic interstitial nephritis, &c. (Fig. 939). Finally, should decomposition occur in the urine retained in the bladder, it may extend through the orifice of the ureter to the kidney; and in this way a large proportion of patients suffering from prostatic disease die of septic suppurative nephritis.

Moral Effects of Enlarged Prostate.—The irritation of a congested and enlarged prostate will excite libidinous ideas in the aged, which may lead to the perpetration of acts of indecency—such as exposure of the person, indecent assaults on children, or to a general impairment of the moral tone. But not only does the diseased state of this body thus excite a depraved condition of the mind; the converse will also happen. And if the true history of many cases of prostatic congestion and hæmorrhage were told, the diseases would be found to begin in irregular sexual or erotic excitement by which the genital organs have been over-stimulated.

Bar at the Neck of the Bladder.—Under this name has been described a transverse ridge or fold obstructing the internal orifice of the urethra, and causing symptoms exactly analogous to those produced by hypertrophy of the middle portion of the prostate. According to Sir Henry Thompson, the ridge or fold is in the great majority of cases actually caused by an outgrowth from the middle portion of the gland. In exceptional cases, however, it may be due to hypertrophy of the muscular fibres at the neck of the bladder, produced by long continued irritation, usually caused by chronic cystitis from stone or stricture. Lastly, in very rare cases, a valve-like fold of mucous membrane may be drawn up by enlargement of the lateral lobes without affection of the median portion of the gland.

The **Symptoms of Enlarged Prostate** arise primarily from the mechanical obstacle offered to the escape of the urine. The first symptoms usually consist in the feeling of a necessity to strain slightly before the urine will flow; and then, after the bladder has been apparently emptied, in the involuntary escape of a small quantity of urine. The patient also finds that he is much longer than usual in emptying the bladder; for, though the stream flows freely enough as soon as it has once begun to escape, yet it cannot be properly projected, the viscus having, to a certain extent, lost its tonicity. It commonly happens that the more he strains the less readily will the urine come away, whereas when he remains quiet, it will usually flow with more freedom. This is especially the case in pedunculated enlargements of the middle lobe. About this time frequency of micturition usually becomes a marked feature, especially at night. In fact, the great majority of patients apply to the Surgeon, not on account of difficulty in passing water, but because they are called upon to perform the act of micturition too frequently. This condition may gradually increase till it amounts to actual dribbling. The frequent discharge of a small quantity of urine may lead the incautious Surgeon to suppose that the patient is affected with true incontinence of urine or with irritability of the bladder. This error may always be guarded against by careful examination of the pubic region by percussion and palpation. Dulness will often be found extending half-way to the umbilicus, and the tense distended bladder may be readily felt above the pubes. If there is any doubt the patient must be made to pass water, and immediately afterwards a soft catheter must be passed. In this way the presence of residual urine and its quantity is determined.

The symptoms may for a long time remain limited to frequency of micturition with some difficulty in the act. The urine remains acid and normal in every respect, and the patient suffers but little, if at all, in his general health. The condition is, however, always one of considerable danger. The over-distended bladder is always prone to slight attacks of cystitis from exposure to cold or other causes. The urine then becomes cloudy from excess of mucus, and often acquires an offensive fishy smell, while still remaining acid. The mucus accumulates in the pouch behind the enlarged prostate, and is with difficulty expelled. Under these conditions ammoniacal decomposition may readily take place. This may occur without the passage of instruments, but in a considerable proportion of cases is not noticed before the use of the catheter has been commenced. Should it happen, the cystitis becomes more acute, and the symptoms of septic poisoning—febrile disturbance, great depression, brown tongue, nausea, delirium, &c.—may set in and terminate fatally, when septic inflammation of the kidneys, by extension up the ureter, will usually be found to have been the immediate cause of death.

Complete Retention of Urine from Enlarged Prostate is a common complication of the disease. It may arise in a patient who has not been able to empty his bladder for some time, and is little more than an aggravation of his usual condition, or it may occur in an old man whose prostate is considerably enlarged, but who, under ordinary circumstances, gets rid of his urine without difficulty. In the latter case it is due to congestion and swelling of the diseased gland, usually induced by exposure to cold, or alcoholic or venereal excesses. It is especially apt to occur after drinking the sour, bad wines usually provided at public dinners.

Diagnosis.—The exact condition of the enlarged prostate can be ascertained only by examination through the rectum and urethra. By rectal exploration with the finger, the degree of enlargement of the lateral lobes can best be ascertained ; though, as in many cases the end of the finger cannot reach the further extremity of the gland, it will be impossible to say to what extent the hypertrophy has extended. The urethral exploration must be conducted by means of a long gum-elastic or a silver prostatic catheter, and will afford information that rectal exploration cannot give ; by it are ascertained approximately the size of the middle lobe, and the condition of the urethra as to elongation and curve.

The diagnosis of obstruction in consequence of enlarged prostate has to be made from that produced by, 1, Stricture of the Urethra ; 2, Calculus of the Bladder ; 3, Vesical Tumour ; 4, Chronic Cystitis ; 5, Atony of the Bladder ; 6, Paralysis of the Bladder.

1. In *Stricture* the stream of urine is small, but the jet is increased by straining, while in enlarged prostate the stream is dribbling, but not reduced in volume, and straining only makes matters worse. Stricture most commonly occurs before middle life, prostatic disease always after. In stricture the obstruction is within six inches of the meatus ; in prostatic disease it is at least seven from the orifice. It is not wise, however, to trust too implicitly to measurements in inches, as the penis varies considerably in length. If the finger be passed into the rectum, it can at once be determined whether the point of obstruction is in front of the apex of the prostate.

2. *Calculus* presents many symptoms in common with enlarged prostate, and its more special symptoms may be absent. In stone the frequency of micturition is greater by day, in prostatic disease it is worse at night. The presence of a small quantity of florid blood in the urine passed after exercise should make the Surgeon strongly suspect the presence of a stone ; but the use of the sound will alone lead to an exact diagnosis.

3. *Vesical Tumour* gives rise to more pain and tenderness on the introduction of instruments than prostatic enlargement ; and the urine generally contains blood and mucus, often with sabulous matter. Microscopic examination of the contents of the urine may show the presence of the tissues of the tumour. Malignant tumours may often be felt through the rectum ; while villous growths give rise to the almost constant presence of blood in the urine.

4. In *Chronic Cystitis*, without complication, the absence of the physical

signs of enlarged prostate, as ascertained by examination by the rectum and urethra, will establish the diagnosis.

5. *Atony of the Bladder* is, as before stated, very commonly associated with enlarged prostate. Its absence would be shown by the urine flowing from the catheter in a steady stream, not influenced by the respiratory movements, indicating an active contraction of the bladder.

6. True *Paralysis* of the bladder, accompanied with a similar affection of other parts, is recognized by its concomitant conditions, and by the absence of physical signs of enlarged prostate, and, as in atony, by the passive nature of the flow of urine through the catheter.

Treatment.—In the treatment of enlarged prostate, little can be done by medical means; though the patient's condition may be somewhat ameliorated by remedies calculated to lessen irritation about the urinary organs, and to improve the condition of the urine. If it be very acid, alkalies with henbane should be given. If the symptoms of chronic cystitis make their appearance the various remedies recommended in the treatment of that disease may be given. If hæmorrhage occur, tincture of perchloride of iron, infusion of uva ursi, or gallic acid, will be useful. Counter-irritation, the application of iodine, and other measures calculated to promote absorption of the enlarged gland, are not of the slightest service.

In the great majority of cases the sole treatment of enlarged prostate consists in the regular use of the catheter, in order to draw off retained urine; and when once this treatment has been commenced, it must be continued for the remainder of life, the patient being taught to use the instrument for himself. It is especially necessary to empty the pouch that forms in the *bas fond* of the bladder behind the prostate; this, being below the level of the urethra, tends to collect an accumulation of viscid mucus and fetid urine which the patient cannot expel without aid, partly from their gravitating into this pouch, and partly from the muscular power of the organ being impaired. The removal of these matters is of great importance; as they may, by undergoing putrefaction, give rise to septic poisoning. The bladder should be effectually emptied at least *twice every day*. Hutchinson states "that in almost all cases of prostatic retention, a flexible india-rubber catheter without a stylet can be passed into the bladder." Its use is so perfectly painless and free from danger, that it should always be tried before adopting more severe measures. If from any cause it be necessary to retain such an instrument, Hutchinson uses a nozzle with rings passed into the orifice of the india-rubber catheter, and fitted with a "styletted plug." The nozzle is about three-quarters of an inch in length, and is fitted accurately by the plug. The stylet reaches about two inches down the catheter so as to stiffen it. With such an instrument in use, the patient need not be confined to bed. If the soft rubber catheter will not pass, by far the most convenient instrument in

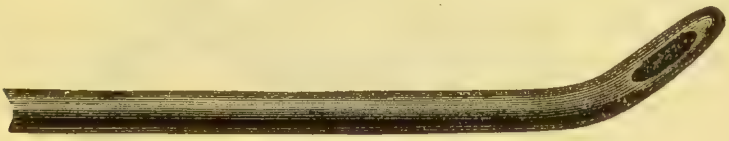


Fig. 940.—Elbowed Catheter.

the majority of cases is the soft French "elbowed" catheter—the "cathéter à coude," of the size and shape here represented (Fig. 940). The stem is soft and pliable, but the angle and eyed point are made of firm gum-catheter material. By keeping the point well up against the urethra, it will often slip in very easily and smoothly in cases of enlarged prostate. These catheters are made with their points bent at different angles or with double elbows, instead of single, and very often when one will not pass, another of a slightly different form will slip in readily. The size of the instrument is of some importance. As a rule, No. 8 or 9 passes most easily. There is nothing gained by using a smaller instrument, as the passage through the diseased prostate, although it obstructs the flow of urine, is always larger than that through a healthy gland.

If neither of these instruments will enter the bladder, a common French conical instrument may pass; but this very rarely succeeds when the coudé catheter fails.

A common gum-elastic catheter of full size, which may be bent to any angle in hot water and fixed by immersing it in cold, may pass when other instruments fail. Sometimes, if it be bent to a curve like that of a lithotrite, it may slip over the enlarged middle lobe. It must be remembered that the heat of the urethra soon causes the catheter to lose the form impressed upon it, and consequently, if it does not enter at once, prolonged attempts to pass it are useless.

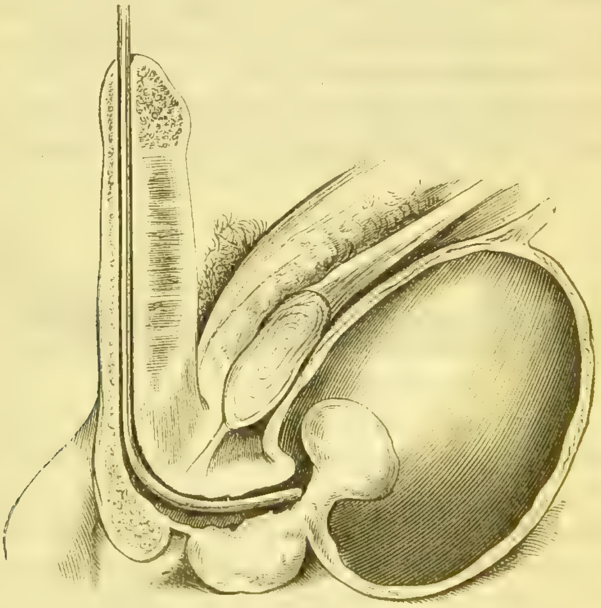


Fig. 941.—Enlarged Middle Lobe of Prostate, arresting progress of the Catheter.

Sir B. Brodie recommended that a gum-elastic instrument, long and of large size, on a well-curved stylet, so that it might preserve its curve when that is withdrawn, should be kept in readiness for these cases. A manœuvre mentioned by Sir B. Brodie will often be of use in surmounting a large middle lobe; viz., after passing the gum-elastic catheter as far as it will go, to withdraw the stylet slightly, so as to tilt up the point of the catheter, which then slips over the obstacle.

If none of the foregoing means succeeds, the Surgeon must have recourse to silver instruments. If the prostate be much enlarged it may be necessary in order to reach and empty the bladder, to use a prostatic catheter. This instrument should be of large size, about No. 12. In order properly to enter the bladder, which is carried away from the surface by the elongated urethra, the prostatic should be about four inches longer than an ordinary catheter ; and, as the neck of the viscus is usually pushed up high behind the pubes by the projection upwards of the lateral lobes, the curve of the instrument should be greater and longer than usual. I find the best-shaped prostatic catheter to be one, the curve of which is exactly the third of the circumference of a circle five-and-a-half inches in diameter. The eyes should be large and rounded ; and I have found it of use to have the lower end of the stylet provided with a piston-plate, so that, by withdrawing this, the mucus may be sucked in through the eyes of the instrument. In introducing the catheter, care must be taken when the point enters the prostatic portion of the urethra, to depress the handle well between the thighs, while the instrument is drawn slightly towards the pubes, lest the end hitch against the enlarged middle lobe (Fig. 941). If it be simply depressed, without at the same time being held back a little, it will probably tunnel the obstruction. In some cases the ordinary catheter passed in the same way will enter more easily than the prostatic. It is sometimes possible to lift the catheter over the obstruction by pressing on it with the finger in the rectum. In fact, no one curve or one kind of instrument will answer in all cases. If it is necessary to use a rigid instrument, I certainly think a silver instrument is safer and more easily managed than the gum-elastic. It might be supposed that less chance of mischief would result from the gum-elastic than from the metallic catheter, as being the softer and more yielding instrument ; but this is erroneous, if the stylet be allowed to remain in, as it is then as rigid at the point, as hard, and as likely to penetrate soft structures as a silver one would be. The patient himself should use a soft instrument, if possible, but it occasionally happens, as occurred in a case under my care, that no soft catheter of any shape could be made to pass ; in such cases he can easily be taught to use a metal instrument.

Operative Treatment of Enlarged Prostate.—Various operative proceedures have been proposed from time to time for the relief of difficult micturition from enlarged prostate or bar at the neck of the bladder, but at present none has come into general use. Among the most important of these was Mercier's operation of division of the bar at the neck of the bladder. This was done by means of an instrument shaped like a lithotrite, the male blade of which was represented by a concealed knife cutting both on its concavity and convexity. The instrument was passed into the bladder, turned round so that its concavity rested on the prostate, and the knife was then withdrawn for a short distance cutting through the bar. Mercier also devised another instrument like a lithotrite, by which he could cut a groove through the bar, taking away a portion of the substance. This operation has recently been revived in a modified form by Bottini of Milan. He divides the bar in the same way as Mercier, but instead of a knife he uses a platinum wire heated by electricity, which can be withdrawn from the concavity of an instrument resembling a lithotrite. By this means he overcomes the danger of hæmorrhage which accompanied Mercier's proceedings. Reginald Harrison, feeling the uncertainty of these methods, has practised division of the prostate through the ordinary perinæal incision employed in digital examination of the bladder (p. 1100). He divides the bar partly with a probe-pointed bistoury, and partly by divulsion with his finger. He then inserts a large gum-elastic tube through which a soft catheter can be passed into the bladder for drainage. The pressure of the tube maintains the channel made by division of the prostate. It must be retained for many weeks. Lastly, within the last few months, F. McGill of Leeds, and Socin of Leipzig, have advocated removal of the obstruction by suprapubic cystotomy. McGill has published three cases in which he has successfully performed this operation with great benefit to the patient. He removes the projecting lobe with scissors and forceps, or by enucleation with the finger. The value of these operations is still an unsettled point. Even the simplest of them is not unaccompanied by danger, and if the patient can easily pass a catheter for himself, and is free from any other complication, it seems hardly justifiable to submit him to an operation, the benefit of which is doubtful, and which may prove fatal. If, however, the patient cannot pass the catheter, or suffers from constant cystitis with great irritability of the bladder, or from frequent hæmorrhage, some operative proceedure gives the best chance of relief. Mercier's operation and its modifications have not yet been attended by such a degree of success as to inspire surgeons in general with any confidence in their utility. On the other hand, suprapubic drainage has for some time past been recognised as the best treatment in cases of prostatic disease which cannot be relieved by catheter, and the experience of McGill's cases seems to show that it is not only justifiable, but advisable to extend the operation to the removal of the cause of obstruction if possible. All his cases were undertaken on account of cystitis and other complications, but he suggests the possible extension of the operation to uncomplicated cases.

Suprapubic Drainage was first suggested and practised by Sir H. Thompson in 1869, as a means of relief when frequent calls for the use of the catheter and constant cystitis made the patient's life unbearable. The opening was permanently maintained by a gum elastic catheter fitted with a silver shield and provided with a rubber bottle to receive the urine.

Treatment of Complete Retention from Prostatic Enlargement.—In these cases the patient must be relieved by an instrument as soon as possible, as elderly people are liable to suffer severely if there is any delay, fever soon setting in, which may be fatal.

It cannot be too forcibly insisted on that in these cases there is no actual narrowing of the canal. The enlarged prostate is no doubt swollen, but there is always sufficient space left for the passage of the largest catheter, if only the proper way can be found. Nothing is gained by using small instruments; anything below No. 8 or 9 (English) is liable to wound the swollen mucous membrane, and cause troublesome hæmorrhage. In complete retention the various modes of overcoming the obstacle in the prostate, which have just been described, must first be attempted, beginning with soft instruments, and using silver only after these have failed. If the retention is thus relieved, it becomes a question whether the catheter should be left in the bladder or withdrawn after the viscus is emptied. As a general rule, it is certainly far better not to leave the catheter in, for the reasons given at page 1095. The instrument should be introduced twice in the twenty-four hours; and care should be taken, if possible, to empty the pouch behind the prostate by depressing its point. Should the mucus be very viscid and offensive, the bladder may be washed out. After the bladder has been emptied for the first time, it will be found to refill in the course of a very few hours, usually in six or eight, the secretion of the kidneys appearing to be set free on the removal of the pressure.

Should any great difficulty be experienced in introducing the catheter, it may be thought desirable to leave it in the bladder for two or three days ; and then a gum-elastic one is always to be preferred, as in these circumstances it presents a great advantage over the silver catheter, becoming soft, accommodating itself to the shape of the parts, and not being so liable to irritate the mucous membrane with its point, which, dipping down into the pouch behind the prostate, acts as a syphon, emptying this part of the bladder far better than a silver catheter could do.

Should the Surgeon *fail to pass any instrument into the bladder*, it becomes an important question what course is to be pursued. Aspiration of the bladder above the pubes may safely be tried as a first resource, and possibly after this a soft instrument may be made to enter the bladder, and if necessary, may be tied in. If this cannot be done, when the bladder fills again more efficient means must be adopted. In these cases, which, however, very rarely occur, three lines of practice may be adopted ; *puncture of the bladder above the pubes*, *puncture through the rectum*, or *forcible catheterism.*

Puncture above the Pubes is seldom required. Since the University College Hospital was opened, only three cases have presented themselves in which it was thought proper to adopt such a proceedure for retention from enlarged prostate ; and in one of these cases, which was under my care, the enlargement of the prostate was complicated with impermeable stricture, which was, indeed, the main cause of the retention. The operation consists either in pushing the trochar at once through the abdominal wall ; or else, as in tapping for ascites, making a small incision about half an inch in length through the integuments, exactly in the mesial line, immediately above the pubes, and then pushing a curved trochar, with its concavity downwards and backwards, into the bladder behind that bone, and consequently underneath the reflection of the peritoneum (Fig. 942). After the bladder has been emptied, the cannula or an elastic gum tube must be left in for the escape of the urine, whilst the continuity of the natural passage is being restored. When the bladder is greatly distended, in consequence of retention from enlargement of the prostate or any other cause, the peritoneal reflection is carried up with it, and a considerable portion of the anterior wall of the organ uncovered by peritoneum is left above the pubes. In a case of unrelieved retention from stricture, in which the patient died suddenly during the administration of chloroform, and which I had an opportunity of dissecting, I found that the summit of the bladder reached to five inches above the symphysis pubis, and was only two inches below the umbilicus ; that the line of reflection of the peritoneum was $3\frac{1}{2}$ inches above the bone ; and that the space uncovered by serous membrane was $2\frac{1}{4}$ inches wide. The bladder contained nearly forty ounces of urine, the retention having lasted forty-eight hours.

It has been suggested that suprapubic cystotomy should be performed instead of simple puncture, and an attempt made to remove the obstructing lobe. It is probable that this would add but little to the patient's danger, but further experience is required on this point.

Puncture through the Rectum is not generally a safe procedure in retention from enlarged prostate, as the hypertrophied gland often encroaches on that part of the inferior fundus of the bladder which is uncovered by peritoneum. When, however, the retention arises from enlargement of the urethral portion rather than of the lateral lobes, this operation may be safely done ; and, indeed, I have known it put in practice with advantage in such cases (Fig. 942).

A procedure that was formerly recommended by Brodie, Liston, and most Surgeons of authority in these matters, was **Forcible Catheterism,** or **Tunnelling the Prostate.** As the retention is generally owing to an enlargement of the urethral portion of the prostate, relief was afforded by pushing the point of a silver catheter through this obstacle into the bladder. A false passage was thus purposely formed, in which the instrument was left for about forty-eight hours, when it would usually enter it again with sufficient readiness on being re-introduced. This practice has, however, been very generally rendered unnecessary by the use of improved instruments, aided by anæsthetics ; and "tunnelling the prostate" may be looked upon as belonging to a past age of Urinary Surgery, ruder than the present.

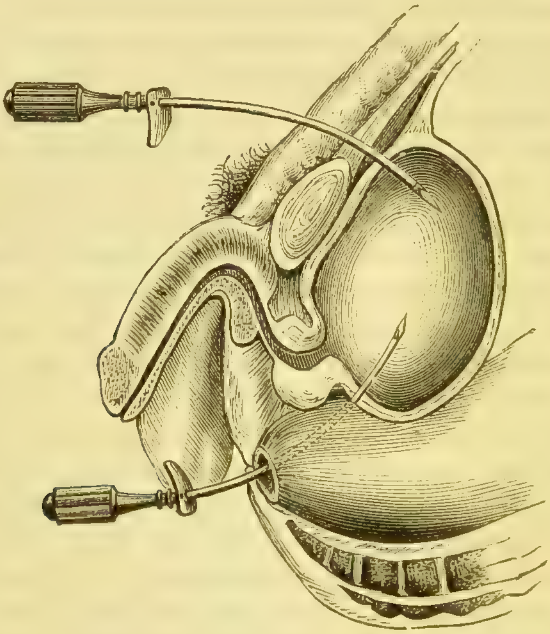


Fig. 942.—Puncture of the Bladder. The upper instrument is in the position of Puncture above the Pubes ; the lower in that of the Puncture through the Rectum.

When the bladder has been relieved, the patient must be freely purged. Belladonna suppositories are often of use, but if there be much pain, opium or morphia will be preferable. In a few days the congestion of the prostate passes off, and the patient may be again able to pass water unaided. In many cases, however, the bladder of an old man which has, perhaps, not been completely emptied for some time, becomes permanently atonic after a single attack of retention, and he is never able again to dispense with the catheter.

OTHER DISEASES OF THE PROSTATE.

Atrophy of the Prostate sometimes occurs. It may be the result of exhausting disease, especially phthisis, of old age, of mechanical pressure from tumours or calculi, or of local disease of the gland itself. Congenital deficiency of the prostate may also occur.

Cancer of the Prostate.—The prostate is not commonly attacked by cancer, but I have seen several instances of it. The form met with is most commonly scirrhus ; one case of colloid has been recorded by Stanley Boyd. I have seen true scirrhus in a man about 70 years old. He died with secondary tumours in the lymphatic glands, and with a liver studded with cancerous nodules.

The **Symptoms** are obscure pain and irritability about the neck of the bladder, with the occasional passage of blood. Digital examination by the rectum will probably detect a hard, ill-defined mass, occupying the situation of the prostate, nodular on the surface, and often peculiarly fixed. It is slightly tender on pressure. The rapid increase in size, with obstruction to the passage of urine, and frequent hæmaturia and increasing pain, will reveal the true nature of the disease.

The only **Treatment** that can be adopted is that calculated to relieve the bladder from the mechanical obstacle to the escape of urine, and to palliate suffering by ordinary means.

Tubercle of the Prostate is not uncommonly met with. It usually forms a part of extensive tubercular disease of the genito-urinary tract. In fact it is rare to find it sufficiently advanced for a diagnosis to be made without one or both epididymes being similarly affected, and it is often very difficult to tell where the disease originally commenced. The vesiculæ seminales are usually implicated, and the tubercular infiltration frequently extends to the floor of the bladder. Not uncommonly it is associated with tubercle of the kidney. The *post-mortem* appearances are those of tubercle elsewhere. Softening yellow masses are found usually near the urethral surface. After a time the mucous membrane gives way, and a ragged cavity with yellow walls is left in the floor of the prostatic urethra. Sometimes the tubercular abscess may open into the rectum, and thus a fistula may be left between the urethra and the bowel. More rarely it causes an abscess pointing forwards in the perinæum. Tubercle in the lungs is usually present at death. The *Symptoms* vary much, according to the situation of the ulceration. If it is limited to the prostate, it may cause surprisingly little disturbance. In a case which occurred in University College Hospital, the patient died of tubercular meningitis, some months after castration for tubercular testicle. At the *post-mortem* examination two cavities were found in the prostate large enough to admit the top of the thumb, but the patient had made no complaint of any urinary trouble. If the ulceration extend towards the bladder, there may be extreme symptoms of irritable bladder. Digital examination by the rectum shows the prostate to be hard, nodular, and irregularly enlarged. Sometimes a softening patch may be detected in it. The vesiculæ seminales, if they can be reached, are usually found to be enlarged. There may be a purulent discharge from the urethra, and pus in the urine. The detection of the tubercle bacillus would determine the nature of the case. The *Treatment* is merely palliative. The disease is too widely disseminated when first recognized to make it possible to do anything by exposing the gland and scraping it.

Cysts or **Cavities** are sometimes found in the prostate ; they may be dilatations of gland-follicles, abscesses, or cavities containing concretions or calculi.

Prostatic Calculi have already been described in the Chapter on Urinary Calculus (Vol. II., p. 1074).

CHAPTER LXXII.

DISEASES OF THE URETHRA.

URETHRITIS.

Simple Inflammation of the Urethra is especially apt to occur in strumous, rheumatic, or gouty individuals, from slight sources of irritation that would not excite it in more healthy constitutions. In strumous children, it may arise from worms in the intestines, or from gastric irritation; and in gouty or rheumatic subjects, it appears often to occur in connection with an acid state of the urine. Excessive beer drinking may cause a slight discharge from the urethra—the "Biertripper" of the German students. In other cases, the irritation of a stricture, the passage of instruments, or ordinary sexual intercourse, may occasion the disease, without there being anything of a specific character about it. Contact with women who are out of health, pregnant, or suffering from leucorrhœa, often gives rise to local irritation of this kind. Urethritis, especially when arising from sexual intercourse, is frequently mistaken for gonorrhœa. From this it may, as a rule, be distinguished by the less intense degree of inflammation, and by the absence of the secondary consequences that frequently follow true gonorrhœa; yet, in many instances, the diagnosis is extremely difficult, especially from the subacute forms of gonorrhœa that are common in London.

Symptoms.—Urethritis is characterized by heat, pricking, and tension about the urethra for a day or two, followed by muco-purulent discharge, often rather profuse, and accompanied by some ardor urinæ. The symptoms are not severe, and the disease usually subsides at the end of a week or ten days; but sometimes it becomes chronic, especially if conjoined with stricture, and is then extremely troublesome, particularly in gouty individuals.

Treatment.—The treatment of urethritis is mildly antiphlogistic. The bowels should be kept open, and salines freely administered; in cases in which there is reason to believe that the affection is of gouty origin, small doses of colchicum, in combination with alkalies, will be found of especial service. The use of emollient or slightly astringent injections, such as opiate lotions, or a very weak solution of acetate of lead, with belladonna, will be found serviceable as the disease is on the decline, but not until then; and when the affection has reached a chronic stage, small doses of copaiba may be advantageously administered. The diet in all cases should be of the blandest character, stimulants of all kinds being interdicted.

If the disease be conjoined with slight stricture, it may not unfrequently give rise to temporary retention of urine. This may, however, most commonly be readily relieved by leeches to the perinæum, the warm hip-bath, and salines, with, perhaps, opiate suppositories, and plenty of demulcent drinks. The catheter should not be used, if it be possible to give relief without it.

GONORRHŒA.

Gonorrhœa is a specific disease, accompanied by inflammation and an abundant muco-purulent discharge; affecting the urethra most commonly, but also the other mucous membranes of the genital organs, as of the prepuce and the glans in the male, and of the vulva and vagina in the female.

The urethra is the usual seat of gonorrhœa in the male; and the disease may be looked on as an infectious urethritis. Its seat of greatest intensity is usually the fossa navicularis; but it may extend over a much greater surface, affecting the entire length of the canal, and even the whole mucous lining of the bladder. In the female it commonly spreads over the extensive mucous surface of the external organs of generation, and sometimes invades the uterus and Fallopian tubes.

Cause.—Gonorrhœa has its origin in the female, and is possibly developed in prostitutes without infection from the male. It is a highly infective inflammation of the mucous membrane of the vagina, predisposed to by the decomposition of retained semen and of foul discharges, the result of repeated acts of indiscriminate intercourse without proper attention to cleanliness. It is impossible to say clinically where urethritis or vaginitis ends, and infective gonorrhœa begins. In the male, gonorrhœa arises in all cases from communication of the specific poison from the female by sexual intercourse.

The poison of gonorrhœa differs entirely from those of the venereal diseases described in Chapter XXXVI., as has been fully proved by inoculation; these diseases not being capable of reproducing one another in any circumstances. The pus from gonorrhœa always contains a definite form of micrococcus, and it has been maintained by Neisser, Bokai, Bockhart, and others, that this organism is the actual virus. Bokai inoculated six students with the organism, which had been cultivated in suitable fluids, and in three gonorrhœa followed. Bockhart also successfully inoculated the organism in the urethra of a man after it had been cultivated to four generations in prepared gelatine. It seems probable, therefore, that the "gonococcus," as it has been termed, is either the actual virus or in some way connected with its development.

The suppurative inflammation of gonorrhœa has these peculiarities: 1. It has a distinct and lengthened period of incubation; 2. It rapidly propagates itself along the mucous tracts that it affects; 3. It is contagious in the highest degree not only when the pus is applied to, and, as it were, rubbed into the mucous surfaces of the generative organs during coitus, but when it simply touches other mucous surfaces; and, 4. It is sometimes attended by remote constitutional phenomena partaking of a pyæmic character.

Character.—Gonorrhœa is usually looked upon as a purely local affection of the genital organs; but although in the early stages it is doubtless a strictly local affection, yet it is occasionally followed by a train of very characteristic phenomena, that can scarcely be looked upon in any other light than as the result of constitutional infection; the more so, as some individuals never have gonorrhœa without the disease being followed by these sequences, whilst others are altogether exempt from them. The parts that are secondarily affected are chiefly the fibrous tissues, the mucous and the cutaneous surfaces. The affections of the *fibrous tissues* give rise to so-called rheumatism and to peculiar forms of inflammation of the testicle and of the sclerotic. The affection of the *mucous membranes* displays itself in specific inflammation of the eyes.

The occurrence of these various affections, assuming as they do a specific type so distinctly marked that they can at once be characterized as gonorrhœal, certainly tends to show that the disease impresses the constitution in some peculiar manner, somewhat analogous to syphilis or pyæmia ; though in a far minor degree, and with much less certainty, than these diseases.

Symptoms.—The symptoms of gonorrhœa in the male may be divided into three stages :—1. The Incubative Stage, or the period of Irritation ; 2. The Acute Inflammatory Stage ; and, 3. The Chronic Stage.

1. **Incubative Stage.**—The first stage, that of irritation, usually comes on from two to three days after connection, when the patient begins to experience some degree of heat, itching, and general irritation about the penis. The lips of the urethra are somewhat red and swollen ; its orifice gapes ; and, on squeezing it, some mucus exudes. This stage usually continues for three or four days from the time of infection, but sometimes for six or eight, when it terminates in the second, which is one of active inflammation.

2. **Acute or Inflammatory Stage.**—The discharge now becomes abundant, thick, and of a greenish-yellow colour ; there is great pain in making water, with considerable heat and smarting, and the urine, which flows in a diminished stream, is passed with increased frequency. The urethra is swollen, firm, and cord-like to the touch ; the whole penis, indeed, looks generally red and turgescent. As the disease advances, and the bulbous portion of the urethra becomes affected, weight and tension in the perinæum will be complained of. If the prostatic portion be the seat of disease, there will be heat and weight about the anus, with frequency of micturition and some strangury. During the whole of this period there is generally a good deal of constitutional disturbance, restlessness, and fever.

One of the most troublesome symptoms in this stage is the occurrence of **Chordee**, which consists in painful erections at night, with a twist in the body of the penis, which is usually curved downwards.

3. **Chronic Stage.**—The acute symptoms usually continue for about a fortnight, when the third stage, that of subacute or chronic inflammation, sets in. During this period of the affection the inflammatory symptoms gradually subside, but a thin muco-purulent discharge keeps up, with some degree of heat and irritation about the urethra, and occasional smarting in passing urine. Under proper treatment, this usually subsides in the course of another fortnight or three weeks ; but, if neglected, or in certain constitutions, it may last for many months, or even years, then degenerating into a *Gleet.* In proportion to the continuance of the affection the inflammatory symptoms subside, though the specific and contagious character does not disappear, and the infection may continue so long as the discharge keeps up. Hunter mentions the case of a girl who had been two years in the Magdalen Hospital, and who infected a person with whom she had connection immediately after she left that institution. The persistence of the contagion of gleet is, it is true, more marked in women than in men. So long, however, as any purulent discharge continues from the male urethra, though it be but a daily drop, the patient must be looked upon as infectious.

The severity and the continuance of gonorrhœa are often opposed to one another. Thus the disease is most severe in young and plethoric persons, and in first attacks ; but it is most difficult of cure in strumous and phlegmatic constitutions, more especially if there be a gouty or rheumatic tendency co-existing, and is very troublesome to remove after repeated attacks. I have observed repeatedly that it is very apt to degenerate into a gleet in people who are subject to chronic eczema.

There is a form of chronic gleet which continues very persistently after an attack of gonorrhœal epididymitis. In these cases the discharge is not so much urethral as testicular. It appears to proceed from the increased exudation from the mucous membrane of the secretory and efferent structures of the testis, during the process of resolution of the inflammation.

The length of time that the infection of gleet will continue in both sexes, but especially in the female, makes it somewhat difficult to say whether the poison of gonorrhœa can be generated *de novo*, as it is not improbable that many individuals communicate the disease, believing themselves to be perfectly cured, though still suffering from slight gleet.

Gleet.—The term *gleet* is applied to any mucous or muco-purulent discharge, which is very small in amount and persists for an indefinite time unaccompanied by any other obvious symptoms. This condition is one which gives rise to great mental uneasiness in many patients, and some varieties are, moreover, liable to terminate in stricture if unrelieved. The correct diagnosis of its nature and source is, therefore, of extreme importance. In the first place, it is necessary to remember that in young men a somewhat copious flow of mucus is apt to accompany an erection of the penis. When, as is frequently the case, an erection occurs just before waking in the morning, the mucus may be found glueing the lips of the urethra together, and may be mistaken by the patient for a gleet. Again, true gonorrhœal gleet must not be confounded with prostatorrhœa (see p. 1108). Some information may be derived as to the cause of the gleet by examining the urethra with the *endoscope*. This is a simple metal tube about the size of a No. 12 or 14 catheter, down which light may be thrown by a mirror or an electric lamp. The mucous membrane bulges into the opening at the lower end, and its condition can thus be seen. It requires considerable experience to form an opinion of much value as to the state of the membrane. Desormeaux has shown in this way that a true gonorrhœal gleet is due to the presence of chronically inflamed patches of mucous membrane in the urethra. These patches are purplish or dark red in colour, whereas the normal urethra is a pale pink. Sometimes the surface of the mucous membrane is covered with small granulations, like those seen on the conjunctiva in granular lids. This condition Desormeaux calls "granular urethritis." The patches may be multiple, but more often there is only one situated in the bulbous portion of the urethra. The *symptoms* of such a condition are the following. A slight, sometimes almost colourless, sometimes yellowish, discharge will be found glueing the lips of the urethra together in the morning. This discharge is little affected by diet or stimulants, but is usually greatly aggravated by connection. If during micturition the first few drops of urine be passed into a separate vessel, flocculi of mucus and pus are seen floating in it. There is no pain or discomfort in micturition, but the stream may be slightly narrowed, and a few drops of urine may be retained in the urethra, and dribble away afterwards, as in a slight stricture. These inflamed patches may usually be detected without difficulty by the use of the olive-headed bougie. As the sound passes the inflamed spot, the patient will complain of pain, and on withdrawing it a drop of blood may be found upon its bulb. A slight feeling of resistance to the instrument is also felt.

In other cases the gleet may be due to a chronic inflammatory discharge from the glands and follicles of the urethra. Hill states that it occasionally arises also from small vegetations or warts situated immediately inside the meatus.

The **Treatment of Gonorrhœa** must be conducted with reference to the stage of the disease, but especially with regard to the acuteness of the inflammation accompanying it. It is of two kinds, *rational*, and *specific* or *empirical*. Both plans are useful, and, indeed, usually necessary, but they cannot be adopted indiscriminately. Thus, if specific means be employed during the acute inflammatory stage of the complaint, much mischief may ensue; whilst, if antiphlogistic treatment be persevered in for too long a time, the disease may be kept up indefinitely.

It has been proposed to adopt what has been termed the *abortive* or *revulsive* treatment, during the earliest stages of gonorrhœa; indeed, during the *incubative* period. This method consists either in the injection of a very strong solution of the nitrate of silver into the urethra, or in the application to the inflamed mucous membrane of a strong ointment of that salt by means of a bougie smeared with it; other Surgeons, again, have recommended the administration of very large doses of copaiba at this period. These various plans have, however, deservedly fallen into disrepute. I have on several occasions seen most intense inflammation produced by this mode of treatment, and never, in any case, any good result. Independently of this, it is impossible to know whether the case, in the earliest stage, will prove to be one of simple urethritis or a specific gonorrhœa.

In the *acute inflammatory stage*, attended by heat, swelling of the organ, great ardor urinæ, and abundant muco-purulent discharge, the treatment must be entirely antiphlogistic, the activity of the measures being proportioned to the intensity of the inflammation. If this be severe, warm hip-baths, poppy fomentations, or the envelopment of the penis in warm water-dressing, will be of essential service. At the same time the urine must be diluted, and its acidity lessened, by the patient drinking large quantities of alkaline diluents—barley-water or linseed-tea containing carbonate of potash in solution; and the bowels may be kept in action by the administration, every second night, of a dose of blue pill. Half a drachm of carbonate of potash, with twenty minims of tincture of hyoscyamus in an ounce of camphor water should be given every four or six hours. All alcoholic stimulants, spices, salt food, and coffee must be avoided, the diet being restricted to light slops, and perfect rest enjoined. By such means as these, the activity of the inflammation will be gradually lessened, the discharge becoming thinner, the smarting in micturition less severe, and the erections less painful. The patient should also be desired to pass his urine frequently, so as to wash the urethra clean.

During this stage, or earlier if the nature of the disease is recognized, W. W. Cheyne recommends the use of iodoform and eucalyptus bougies. These are composed of iodoform, 5 gr.; oil of eucalyptus, 10 ♏; oil of theobroma, 35 gr. This is sufficient to make one bougie 4 inches long. It is thus used: the patient first passes water to clean the urethra, he then dips the bougie in carbolic oil (1 in 20) and passes it quickly into the urethra before it becomes softened by the heat of his fingers. It must be pushed in with a pencil, or some convenient instrument, till it completely disappears.

An absorbent pad of iodoform or salicylic wool is then placed over the end of the penis, and covered with oiled-silk or gutta-percha tissue secured by a strip of plaster. The patient then refrains from making water as long as possible. One bougie may be used daily for two or three days, and in the interval some simple injection, such as chloride of zinc (gr. $\frac{1}{6}$ to ℥j), or sulpho-carbolate of zinc (gr. ij to ℥j) may be used. Cheyne states that by these means the inflammation is often cut short and a cure effected in a week or ten days or sooner. If it fails it does no harm. One-twentieth of a grain of perchloride of mercury added to each bougie is said to increase the certainty of their action.

During the second, or in fact in all stages of gonorrhœa, much harm is often done by applying lint to the penis. This does not absorb the discharge, but rather shuts it in. It is better to put the penis in a macintosh gonorrhœa-bag, at the bottom of which a good-sized piece of salicylic wool may be placed to absorb the discharge.

When the *third stage* of the disease has been reached, specific treatment may be employed with great advantage; while, if recourse were had to it at an earlier period, it would certainly increase the inflammation and give the patient much distress. Even in this stage the specific remedies, such as copaiba and cubebs, must be cautiously given; the Surgeon feeling his way with them, and being prepared to discontinue them if he find that they increase the irritation. Should the disease, however, from the commencement, have assumed a subacute character, the specific treatment may with safety be adopted at a much earlier period.

Copaiba and cubebs are extensively used in this stage of gonorrhœa. Of these, copaiba is the least irritating, and consequently most generally to be preferred. It may be administered in a variety of ways; in capsule, pill, draught, or extract. The capsule is generally to be preferred, on account of the nauseous taste being thus more completely disguised; but in many cases it acts with more certainty, and with better effect, if given in either of the other forms. When the capsules are given, the patient may take from six to eight or ten in the day, and should at the same time have an alkaline mixture, which increases materially the effect of the drug. A very excellent mode of administering copaiba is to rub it down into a mass with burnt magnesia, and to let the patient take about a drachm of this paste three times a day, in a bolus wrapped in wafer-paper; or, if the taste be not much objected to, he may take it most advantageously in mucilage, with liquor potassæ and tincture of henbane.

In some relaxed constitutions, and more particularly after frequent claps, cubebs will be found to cure the patient more readily than copaiba, or rather most successfully if given in combination with it. An excellent plan is to put about half an ounce of powdered cubebs into a mortar, and to rub it up with as much copaiba as will form a stiff paste, of which the patient should take a drachm as a bolus thrice daily. The effects of this electuary are often most striking; but it can be used only in the constitutions indicated, and after the more active inflammatory symptoms have subsided. Copaiba in many subjects brings out a red, raised rash, most marked on the backs of the hands and feet, but sometimes extending over the whole body. It is accompanied by considerable itching and often by some rise of temperature. Hill states that a similar eruption, but more papular in character, may follow the administration of cubebs. Hæmaturia has been occasionally observed as the result of large doses of copaiba. Oil of yellow sandal wood may sometimes be employed with advantage, though its action is somewhat uncertain. It may be given in capsules in doses not exceeding twenty minims three times a day, or the following formula will be found useful; oil of sandal wood, ʒij, tragacanth in powder ʒss., water to ℥viij; one ounce to be taken three times a day.

It is during the third stage of gonorrhœa that **Injections** may advantageously be used. Much and very unfounded prejudice exists against their use in the minds of many; but surely it is as safe to apply proper local applications to an inflamed urethra as it is to an inflamed conjunctiva; and the bad consequences, such as stricture and inflamed testicle, which have sometimes been referred to their use, have either been due rather to the long continuance and to the severity of the disease itself than to the remedies employed, or to their application at too early a stage or of too great a strength. It is in long-standing cases of gonorrhœa, in which the discharge continues for months or years, that stricture follows, not in cases of ordinary duration; and it is the result of the chronic inflammatory thickening of the mucous membrane, and has no more to do with the injections than with the copaiba or salines which the patient may have taken. As the ardor urinæ subsides, emollient and slightly astringent injections may be used. The best is perhaps chloride of zinc of the strength of two grains to twelve ounces of water, to which two drachms of extract of belladonna may be added. This injection may be used frequently during the day. Acetate of lead, from one to two grains to the ounce of water, is often useful. If this induce irritation, a few grains of the watery extract of opium may advantageously be added. As the disease subsides, a stronger astringent is required, and then one or two grains of the acetate of zinc may be added to each ounce of the injection; or a weak solution of sulphate may be employed, gr. ij to each ounce of water; or an injection of gr. $\frac{1}{4}$ of the nitrate of silver to the ounce may be used. During the whole of this stage, the diet and habits of life must be carefully regulated, and all stimulants interdicted. The injections should be discontinued as soon as the discharge has ceased; unless this be done, they may re-induce it.

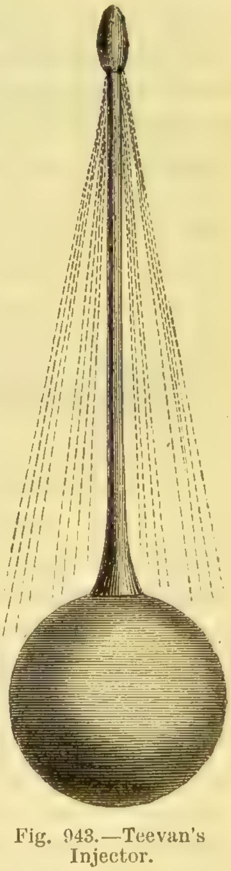


Fig. 943.—Teevan's Injector.

The mode of injection is of importance. A glass syringe should always be used, with a smooth rounded nozzle. The patient sitting on the edge of the chair and holding up the penis, should carefully insert the end of the syringe between the lips of the urethra, and then slowly throw in the injection as far as it will go. Although the inflammation is usually at first confined to the anterior portion of the urethra, yet it in most cases extends to the bulb, and the injection should be applied to the whole length of the inflamed mucous membrane. If any enter the bladder it cannot signify, as it will immediately be decomposed by the salts and mucus of the urine.

Instead of the ordinary glass syringe, the injector (Fig. 943) may be advantageously used. By it, the injection is thrown from behind forwards, so that when passed beyond the inflamed part it washes out the discharge, instead of forcing it further on.

Treatment of Gleet.—In **gleet,** much difficulty will often be experienced in curing the patient of his discharge. Here much depends not only on the administration of proper remedies, but on care being taken attentively to regulate his habits of life. It will constantly be found that, after the disease has apparently been cured, excesses at table, and more especially the drinking of beer, or of effervescing or acid wines, will bring back the discharge. It will return also after connection, though it have previously ceased entirely. This is especially the case in strumous, gouty, or rheumatic constitutions, in which all urethral inflammations are with difficulty removed. In these cases, then, abstinence from alcoholic liquids and dietetic stimulants, and a continent life must be strictly enjoined ; but the local treatment requires careful attention.

In the early stages of gleet an attempt may be made to cure it by injections. For this purpose somewhat stronger solutions are required than in the more acute period of the disease. Sulphate of copper will often be found useful, commencing with half a grain to the ounce, and gradually increasing it to one or even two grains. Tannic acid in the strength of from two to four grains to the ounce will sometimes check the discharge. Soluble bougies, similar to those already described, but containing tannic acid, sulphate of zinc, or acetate of lead, are often of great service. These, combined with the internal administration of copaiba and cubebs, or the perchloride of iron, may effect a cure. If these do not succeed, the occasional passage of a full-sized bougie is of the greatest use. The orifice of the urethra must also be examined for warty growths, which may keep up the discharge.

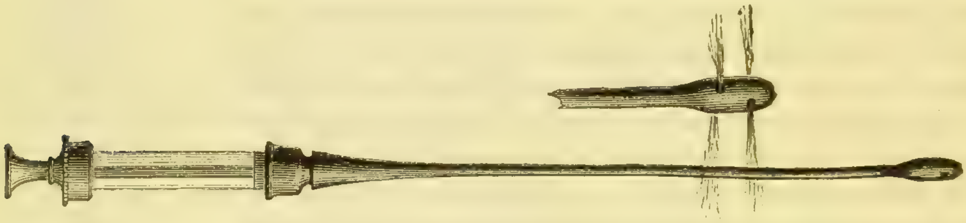


Fig. 944.—Guyon's Injector. The Smaller Figure represents the Nozzle.

When the disease has become very chronic, and has assumed the form of granular urethritis, it is difficult of cure ; for, as Desormeaux has pointed out, no injection, which the healthy portion of the urethra is capable of bearing, will have much effect upon the inflamed patch. He therefore recommends the application of a very strong solution of nitrate of silver through the endoscope ; but equally satisfactory results may be obtained by the use of Guyon's injector (Fig. 944). This consists of a hollow bulbous sound perforated in the bulb, and fitted with a small syringe. The bulbous sound having been passed first up and down the urethra till the exact situation of the inflamed spot is found by the tenderness and slight cling before mentioned, the perforated head is held fixed at the diseased spot, and a few drops of a solution of nitrate of silver (ten to twenty grains to the ounce of water) are injected. The patient should pass urine immediately before the injection, and not again for some hours if possible. Berkeley Hill, who has had great experience of this mode of treatment, states that, if the patient keep quiet for some time after, no complications are likely to follow ; but neglect of these precautions may be followed by swelled testicle or even perineal abscess. After the operation, a weak astringent injection must be used for a few days, and the passage of bougies for a short time after is usually necessary to complete the cure. Otis, of New York, is of opinion that every prolonged gleet is the result of a narrowing of the canal, and he recommends internal urethrotomy as a cure—cutting the urethra up to its normal size by the method described under the treatment of stricture of the urethra. The operation is somewhat severe, and should never be had resort to till all other means have failed.

The treatment of gleet may therefore be summed up as follows. The patient must be carefully examined, in order to detect, if possible, some constitutional condition, such as struma, gout, or rheumatism, which may serve as a guide to general treatment, diet, and use of stimulants. Change of air and sea-bathing are often of essential service. The orifice of the urethra must be examined for warty growths or suppurating follicles. If these are found, they may be touched with nitrate of silver. If they are not found, the electuary of cubebs and copaiba, or one composed of cubebs and the sesquioxide of iron, may be administered with advantage, and the injections recommended for the chronic stage of gonorrhœa may be persevered with. Should these fail, and should the olive-headed sound give distinct evidence of a tender spot, and perhaps a slight narrowing of the urethra, the passage of a full sized metallic bougie every second or third day should be tried. If, after a fair trial, this fail also, injection of nitrate of silver by Guyon's injector must next be had recourse to, followed by mild injections and the passage of bougies ; and, lastly, if everything else have failed, and a distinct narrowing of the canal be present, internal urethrotomy may be tried as a last resource.

Complications of Gonorrhœa.—Gonorrhœa, when acute or virulent, seldom runs its course without local complications of some kind, the result of the propagation of the inflammation to neighbouring parts, often of considerable severity, and occasionally even hazardous to life ;—such as chordee, phimosis, sympathetic bubo, perineal abscess, irritability of the bladder, retention of urine, hæmorrhage from the urethra, &c. Many of these complications present no special features, but require to be treated on general principles, without reference to their specific cause. Others demand more special management, and these we may briefly consider here.

Inflammation of the Lymphatics of the Penis may occur, stretching along the sides and dorsum of the penis in the form of hard thread-like lines, with much redness and œdema of the integuments, and general swelling of the organ, the glans in these cases often assuming a turgid aspect and a dull brick-red colour. This condition is a very serious one, as it may lead to one of two consequences, or both may ensue, viz., inflammation and suppuration of the inguinal glands, or blood-poisoning. It is the latter result that gives rise to the most serious constitutional effects in gonorrhœa, closely resembling the less severe forms of pyæmia.

Chordee, or painful erection of the penis, with twist of the organ, coming on at night, is often a most distressing and troublesome symptom. It is usually best relieved by the application of cold to the part, by the administration at bed-time of a pill composed of gr. j of opium with gr. v of camphor. Ricord recommends a suppository of camphor and opium, gr. x of camphor, and gr. j of the watery extract of opium, to be introduced into the rectum an hour before bed-time, as the best means of removing the tendency to chordee. Full doses of bromide of potassium are sometimes of use.

Acute Prostatitis, presenting all the symptoms described on p. 1106, and in rare cases terminating in abscess, is an occasional complication. It must be treated as there described.

Chronic Prostatitis is rather a sequel of gonorrhœa than a complication. Its symptoms and treatment have been already described (p. 1108).

Inflammation of the Neck of the Bladder with Strangury and Dysuria is not an uncommon complication. It arises from exposure to cold or wet during a clap, and occasionally from the use of too strong injections. The discharge may lessen when the symptoms of the deeper inflammation set in. When the neck of the bladder only is inflamed, the urine remains acid, and contains but a slight excess of mucus. Frequency of micturition, often excessive, and accompanied by the most severe pain, forms the most prominent symptom. Pus and blood may escape with the last few drops of urine. It is distinguished from acute prostatitis by rectal examination, when absence of prostatic swelling and tenderness will be recognized. The inflammation in many cases is less acute, especially when it comes on in the third or fourth week of the clap. In the acute form leeches to the perinæum, hot baths and fomentations, and full doses of Dover's powder, or of henbane and potash, will afford much relief. If the pain is very severe, a morphia-suppository must be inserted into the rectum. In more chronic cases the administration of the perchloride of iron, with belladonna-suppositories, will be beneficial.

Cystitis, of an acute character, may occur by the extension of the urethral inflammation. The urethral discharge diminishes as the symptoms of cystitis come on, or ceases, just as in epididymitis ; the patient is seized with intolerable and frequent dysuria, strangury, and general febrile disturbance. The urine becomes loaded with muco-pus, and may be fetid and alkaline. The condition is perilous. There is danger to life if the constitution be broken, and there is always danger of prolonged or possibly intractable subacute cystitis. Indeed, I believe that many of the cases of chronic subacute cystitis, with muco-pus in the urine, and perhaps atony of the bladder occurring in middle-aged men, may be traced back to the influence of a gonorrhœa contracted in early life. The *Treatment* of this condition consists in the employment of belladonna or opiate suppositories ; the frequent use of warm hip-baths ; the application of fomentations to the perinæum and hot poultices to the pubic region. The free administration of opium is often of great use, and an occasional dose of calomel should be given to relieve the bowels. As the cystitis subsides, the urethral discharge re-appears.

Pyelitis and Nephritis are very rare complications of gonorrhœa. Murchison has recorded two cases in which death rapidly followed extension to the kidney, with coma and delirium. In a case lately in University College Hospital, a slight urethral discharge was followed by pain in the course of the ureter, and the symptoms of pyelitis. The disease assumed a chronic form, the pus in the urine being very abundant. Gonorrhœal rheumatism of a severe form set in at the same time. After about two years the patient partially regained health, the amount of pus becoming very small. In another case in the same hospital, a large renal abscess formed some time after an attack of gonorrhœa, to which it seemed to be directly attributable. The abscess was aspirated twice, and the patient recovered, but at his death some years after, the kidney was found to be shrivelled to a small mass of fibrous tissue.

Retention of Urine from Gonorrhœa may set in at any period of the acute stage. The obstruction is usually dependent on congestion and inflammation of the mucous membrane of the urethra. Leeches to the perinæum, the warm hip-bath, and opiate suppositories, will probably afford relief. It is always desirable to avoid using the catheter, as it is apt to lacerate the swollen and softened mucous membrane, and thus to occasion troublesome bleeding ; and will always produce much pain, and increased irritation of the canal. Should, however, the retention have continued twenty-four hours, or longer, it will probably not give way to the means above indicated, and then it will be necessary to use the instrument, when a full-sized one should be very carefully introduced ; a large instrument entering the bladder as easily as a smaller one and with less risk of injury to the tender walls of the canal. When the catheter has been introduced, it is often somewhat difficult to determine whether it should be left in or taken out. If it be left in, inflammation is increased. If it be taken out, the Surgeon may not be able easily to introduce it again. The solution to this question is to be found in the facility with which the instrument is passed. If it have been introduced without much difficulty, it is better to withdraw it after the bladder has been emptied, and to continue the antiphlogistic treatment, when a second introduction may not be required. If, on the other hand, the catheter have been passed with great difficulty, and be firmly grasped by spasm, it should be left in ; but very active treatment must be employed to prevent it from exciting too much inflammation.

It must, however, be remembered that the retention may be due to more serious conditions : to prostatitis, to abscess in the prostate or the perinæum, or to inflammatory exudation in the tissues about the neck of the bladder. In these circumstances, active antiphlogistic measures will be required, with the use of the catheter twice in the twenty-four hours, and probably free incisions into the perinæum, if there be pus or urine extravasated into that region.

In many cases of gonorrhœal retention, an old stricture complicates the clap. Here the employment of energetic antiphlogistic measures and the use of the catheter are indicated.

Hæmorrhage from the Urethra may occur either as the result of chordee, and consequent rupture of some blood-vessels of the corpus spongiosum, as the consequence of attempts at passing the catheter, or as a kind of exudation from the mucous membrane. Most commonly it may be arrested by the application of ice. If it be apparently due to intense inflammatory hyperæmia, leeches may be applied externally followed by hot fomentations. Should it be abundant, the introduction of a large gum-elastic catheter, and pressure by means of a bandage to the penis or perinæum, will arrest it.

Urethral or Peri-Urethral Abscess occasionally forms in gonorrhœa. It is supposed to result from inflammation culminating in suppuration, taking place in one of the lacunæ or glands of the mucous membrane. An abscess may form at any part of the urethra, but the two most common situations are near the end of the penis and in the region of the bulb. It is possible that in many cases the pus may be discharged into the urethra without being recognized ; but if the collection of pus reaches any size it points towards the surface. In the neighbourhood of the glans it forms a rounded swelling, usually projecting under or to one side of the frænum. It is tender on pressure, and the parts round are swollen and œdematous. It should be opened as early as possible lest it burst into the urethra, after which, as the aperture is usually insufficient to drain the cavity a second opening will form on the surface, leaving a fistula, which is very troublesome to heal.

When the abscess is situated in the region of the bulb, it forms a hard, tender swelling in the perinæum, constituting one of the varieties of *perinæal abscess.* In this situation, also, if opened early by a free incision in the middle line, it will be found to have no communication with the urethra, and will quickly heal without leaving a fistula. If it be not opened in time, it may burrow widely beneath the accelerator urinæ, and the expansion from it covering the penis. Under these circumstances it may be felt both at the root of the penis and in the perinæum, and there may be considerable swelling of the scrotum. The incision in such a case should be made behind the scrotum only. If left too long, a communication with the urethra may have taken place, but provided the incision is made in the perinæum only, it will heal without difficulty.

Sequences of Gonorrhœa.—The sequences, or more remote complications of gonorrhœa, are partly local and partly constitutional. Amongst the loca we find more particularly **Warts** about the prepuce and glans or within the urethral orifice, which require to be treated by excision or caustics ; and **Stricture,** the management of which is fully described elsewhere. In some cases, also, in consequence of extravasation of blood, or inflammatory exudation into the corpus spongiosum or the corpora cavernosa, limited and localized **Induration and Thickening of the Penis** may result, attended by chordee, painful erections, and a permanent twist in the organ. In such conditions as these, an attempt may be made to produce absorption of the effused mass, by the administration of small doses of bichloride of mercury, with the inunction of iodide of lead ointment.

After the cure of a clap that has been of long continuance, the generative organs are often left in a *weak and irritable state ;* the penis, scrotum, and spermatic cords being lax and elongated, with an apparent want of power, and often painful and dragging sensations about the cords and groins.

Besides the strictly local complications of gonorrhœa, certain sequences, to which some constitutions are especially liable, occasionally occur as the result of this disease ; viz., inflammation of the testes and of the eyes, and rheumatism. Some of these, as the affections of the eyes and testes, may be either local or constitutional ; the others are clearly constitutional. The constitutional effects of gonorrhœa offer characters that have some analogy to those presented by the chronic and subacute forms of pyæmia. This is more especially the case in monarthritic inflammation of the knee or wrist, leading to disorganization or permanent ankylosis of the joint.

Gonorrhœal Epididymitis is certainly the most common of these sequences. It almost invariably affects only one testis, and commences in the epididymis, whence it extends to the body of the organ. It usually occurs in individuals who have a lax and long scrotum, with very pendulous testes. It seldom sets in before the third week after the occurrence of gonorrhœa, but may occur at any period during the continuance of the discharge, though it is more frequent between the fifth and sixth weeks than at any other time. In cases of gleet, also, it not uncommonly occurs at a later period. In many instances it is referred to some slight injury—a blow, or squeeze, received during the continuance of the gonorrhœa; but in some cases it would appear to arise from extension of the inflammation along the ejaculatory duct. It was formerly believed to arise in some cases from so-called metastasis of inflammation from the urethra to the testis. That the disease commences in the epididymis, may be advanced in support of the first opinion; whilst the fact that the discharge usually ceases when the inflammation of the testicle comes on, and returns as it subsides, has been adduced in support of the doctrine of its metastatic origin. Curling is of opinion that the diminution of discharge is due to counter-irritation, as he has seen a case in which the urethral discharge ceased, although the orchitis had been occasioned by a blow. As the symptoms and treatment of gonorrhœal inflammation of the testicle present nothing peculiar, I shall reserve their consideration until we speak of diseases of this organ. Gonorrhœal epididymitis is apt to be followed by long-continued gleet, consequent on the exudation from the lining membranes of the vas deferens, and the secretory apparatus of the testes.

Gonorrhœal Inflammation of the Eyes is fortunately not of very common occurrence. It may affect either the conjunctiva or the sclerotica.

Gonorrhœal Conjunctivitis is one of the most destructive forms of ophthalmia, giving rise not unfrequently, in the course of forty-eight hours, to the most intense chemosis, with opacity and softening of the cornea, followed by staphyloma and a discharge of the humours. In the majority of instances only one eye is affected; but, in some, both are involved to an equal extent. The disease commences with the ordinary symptoms of conjunctival inflammation; itching and swelling of the eyelids, velvety redness of the conjunctiva, muco-purulent discharge, with much lachrymation. The chemosis sets in early, and is very severe; and, unless treatment afford speedy relief, the consequences are most disastrous to vision. Lawrence states that, of 14 cases that fell under his observation, 9 had only one eye affected and 5 both. Of the 9 in whom one eye only was diseased, the organ was lost in 6 cases; of the 5 in whom both eyes were affected, both organs were destroyed in one case; in 2 one eye only was lost; one patient recovered imperfectly; and in only one did complete recovery ensue.

It has been a question with Surgeons, whether gonorrhœal ophthalmia is the result of the direct application of the specific pus to the conjunctiva, or occurs as a constitutional disorder. There is no doubt that the application of the pus to the surface of the conjunctiva will occasion the disease; and this is now generally acknowledged to be the only mode of origin.

The *Treatment* of this dangerous affection must be of an active character. The violent depleting measures formerly recommended are now universally condemned. General blood-letting is never required; much relief may however be given by the extraction of a small amount of blood from the temple by leeches. The patient must be confined to a dark room, the bowels must be kept regular, and a moderate diet allowed. The most useful topical agent that we possess is the nitrate of silver. Surgeons differ somewhat in opinion as to the strength of the application; some, the Germans especially, advise that the solid stick should be used; whilst others employ it in solution, of the strength of a drachm to the ounce of distilled water. Wharton Jones employs a weaker solution, one of four or five grains to the ounce, and I have seen cases very successfully treated by this plan; so much so, indeed, that I am disposed to prefer it to the stronger solution. A few drops must be introduced about twice in the twenty-four hours, into the inner canthus of the eye. The conjunctiva may be rendered insensible by cocaine before its application. The lids in the meantime should be kept covered by compresses dipped in weak alum lotion, and the purulent discharge, as it accumulates, carefully washed away by tepid alum injections. Instead of alum, boracic acid may be used with great effect, and lately, a very weak solution of bichloride of mercury (1 in 5000) has been tried with considerable success. In doing this, great care must be taken that none of the discharge come into contact with the eyes of the Surgeon or nurses, as it is highly contagious, and will almost to a certainty produce the disease; instances are recorded in which, in this way, the attendant's vision has been destroyed. If the chemosis be considerable, it must be incised ; and, as the inflammation subsides, belladonna lotions may be employed with advantage, and the use of the nitrate of silver and other lotions gradually discontinued.

Great care must be taken to prevent infection of the other eye when only one is affected. It may be covered with a compress, or, as Dixon recommends, a watch-glass may be placed over it and secured by plaster or collodion.

Gonorrhœal Sclerotitis is by no means of such frequent occurrence as the conjunctival inflammation ; when it happens, it will be found to be associated with gonorrhœal rheumatism, and not unfrequently with inflammation of the testicle, occurring apparently in individuals in whom there is a tendency to affection of the fibrous tissues. This disease is evidently of constitutional origin, as it cannot possibly arise from local contagion ; it is attended by the ordinary signs of sclerotic inflammation, and is usually accompanied by some degree of iritis.

The constitutional *Treatment* is that for gonorrhœal rheumatism. Locally the eye must be protected from light, and a few drops of atropine solution put in occasionally. If there is much pain, blood may be taken from the temple by cupping or leeches.

Inflammation of the Nose, attended by profuse suppuration, the result of direct infection, is a complication that I have more than once had occasion to observe in gonorrhœa. The swelling of the organ is considerable, the tenderness great, and the discharge abundant ; a condition, indeed, of the Schneiderian membrane that seems analogous to the inflammation of the conjunctiva just described. The *Treatment* that I have found to succeed best, consists in fomentations, followed by astringent lotions or injections.

Gonorrhœa of the Rectum has been met with in rare cases. In women it may be the result of infection from vaginal discharge, but in men it is usually the result of unnatural vice. The symptoms are pain in the bowel, with a thick muco-purulent discharge. The *Treatment* consists in injections of acetate of lead and opium.

Gonorrhœal Rheumatism principally occurs in young and otherwise healthy persons. The exact nature of the disease is very uncertain. It is supposed by many to be a form of blood-poisoning analogous to pyæmia. The presence of the gonococcus is said to have been demonstrated in the fluid removed from the swollen joints. Berkeley Hill states that his observations lead him to believe that the disease is met with chiefly in gouty or rheumatic subjects. If the patient have not previously suffered from these affections, a family history indicating a tendency to them will usually be found. In patients who are distinctly rheumatic or gouty, Hutchinson states that any urethral discharge, whether specific or not, may give rise to symptoms identical with those of gonorrhœal rheumatism. The affection is more common in men than in women, and seldom sets in till the third week after the commencement of the discharge, though it may occur as late as the second month. The disease may assume various forms. It may commence insidiously with pain in the joints, quickly followed by considerable effusion. Several joints may be affected, but the knee is attacked with far greater frequency than any other articulation. The febrile disturbance may be slight. The pain and swelling last usually for some weeks, and gradually subside ; but relapses are common. In other cases the course of the affection more closely resembles that of acute arthritis ; the pain is intense, and the ligaments are early affected. The swelling assumes an oval form, effusion into the articular cavity being slight, or even wanting. The constitutional disturbance is severe. This variety most commonly ends in ankylosis. In another form occasionally met with, pain forms the chief symptom, without swelling or interference with movement. Other structures beside the joints may be affected, as the fasciæ, the sheaths of tendons, bursæ, and occasionally the nerves. Gonorrhœal sclerotitis, as already mentioned, is always connected with rheumatism, and orchitis may arise from the same cause. Gonorrhœal may be distinguished from simple acute rheumatism by the attack being less severe, by the affection usually being limited to two or three joints, and often to the knee only, and by the absence of the profuse sweating and the creamy-white tongue. The prognosis is, as a rule, good. Suppuration may occasionally take place, and the disease then merges into that to be immediately described, gonorrhœal pyæmia. Ankylosis is, however, very common, especially in the arthritic form. This arises not so much from destruction of the cartilages, as from shortening and contraction of the inflamed capsule of the joint as recovery takes place. This form of ankylosis is practically incurable.

Treatment.—The first essential point of treatment is to check the urethral discharge as quickly as possible by the means already described. Iodide of potassium, with alkaline tonics, are sometimes of use. Salicylate of soda in large doses has been tried with varying effect. Quinine may be given if the temperature is elevated, and in the later stages perchloride of iron is often of material service. The local joint-affection must be treated by absolute rest on splints, blistering, and strapping over mercurial ointment in the later stages. If ankylosis occurs, it must be treated as described on p. 362.

Gonorrhœal Pyæmia.—It is not easy to draw a clear distinction between gonorrhœal rheumatism and pyæmia. The term pyæmia is applied to those aggravated cases, fortunately of very rare occurrence, in which the joint-affection terminates in suppuration, with complete destruction of the articulation. In these cases abscesses are not uncommonly met with in other parts of the body, especially in the subcutaneous tissue. Visceral abscesses are of very rare occurrence. The symptoms are those of chronic pyæmia (Vol. I., p. 987).

Cutaneous Eruptions, chiefly consisting of roseola, with slight pityriasis, and perhaps a few patches of psoriasis, have been described as occurring occasionally in severe cases of gonorrhœa. The description given by Travers o these eruptions makes them correspond so closely to the early manifestations of syphilis that it is probable that they really resulted from an intra-urethral chancre, mistaken for gonorrhœa. If these cases and those in which the rash arises from copaiba and cubebs be excluded, it is doubtful if any truly gonorrhœal skin-eruptions exist.

Gonorrhœa in the Female differs from the same affection in the male in not being so severe, though it is usually more extensive, and of longer duration. The severity is less, on account of the shortness of the female urethra preventing the occurrence of the retention of urine as in the male, and also from the absence of such parts as the prostate, testes, &c., the implication of which constitutes the principal source of difficulty in men. Gonorrhœa in the female may affect the parts to very different degrees; thus, the vulva alone may be implicated, or, as most commonly happens, the inflammation may spread to the whole of the mucous membrane of the vagina. The urethra is less commonly the seat of disease, though occasionally implicated with other parts; and, lastly, the interior of the uterus may become affected by this specific inflammation. In some cases it will even spread along the Fallopian tubes to the ovaries: and ovaritis and fatal peritonitis also may be induced.

The **Symptoms** of gonorrhœa in women are sufficiently well marked in the early stages, when there is an abundant muco-purulent discharge from the parts affected, with a good deal of inflammatory irritation, accompanied with pain in micturition, and a frequent desire to pass urine. As the disease becomes chronic, however, it is more difficult to determine its true character; it being apt to be confounded with some of those accidental and leucorrhœal discharges to which females of all ages are subject.

Diagnosis.—In the majority of cases, gonorrhœa may be distinguished from all other *muco-purulent discharges* of the female organs, by the presence of inflammation about the external parts, and the mucous membrane of the vagina and urethra. In these cases it will be found, on introducing a speculum (which, however, occasions considerable pain, and is firmly grasped by the contraction of the vagina), that the discharge comes from the vaginal wall, and that the uterine orifice is free from it, or nearly so; whereas in leucorrhœa the discharge proceeds in a great measure from the interior of the uterus, the os and cervix of which will probably also present signs of diseased action. It must, however, be borne in mind that the discharge in gonorrhœa may occasionally be in a great degree uterine; and that that of leucorrhœa may be an exudation from the mucous membrane of the vagina. In such circumstances, when the disease is chronic, it is almost impossible to arrive at a correct conclusion as to the nature of the case from simple inspection; and in these cases of doubt the Surgeon had better give a very guarded opinion, lest he be led into the error of inculpating an innocent woman. The difficulty is increased, and a good deal of obscurity thrown over the case, by the fact that leucorrhœal discharges will occasionally give rise to urethritis in the male, which closely simulates gonorrhœa. Female *Children* also are occasionally subject to an acute inflammation of the vagina and nymphæ as the result of simple irritation, of constitutional disturbance, or of teething; these cases require to be recognized, as they have frequently been the cause of unfounded accusations.

The **Treatment** of gonorrhœa in the female must vary, according as the disease is acute or chronic. In the acute stage, general and local antiphlogistic means—salines, low diet, rest in bed, and emollient sedative fomentations—must be used. As the disease subsides into a chronic condition, astringent injections must be employed; a weak solution of acetate of lead, or the liquor aluminis compositus largely diluted with tepid water, being especially useful.

In other cases, a weak solution of nitrate of silver may be used with much advantage. These injections should be employed three or four times a day and in large quantity. After they have been thrown up, a piece of lint well soaked in the lotion should be introduced between the opposed mucous surfaces, so as to prevent their coming into apposition, the discharge being in a great measure kept up by their friction against one another. In order that the injection may be properly given, the woman should lie flat on her back, and pump in the fluid by means of an elastic bottle. In the treatment of gonorrhœa in women, specifics are of no use unless the urethra be affected, when copaiba may be given, as in the male. The disease is apt to degenerate into a chronic gleety condition, leaving a thin muco-puriform discharge, which will continue to be infectious for a great length of time.

STRICTURE OF THE URETHRA.

Much discrepancy of opinion for a long time existed as to the structure of the urethra, some Surgeons admitting, others denying its muscularity. The presence of muscular fibres in the urethra had been suspected by many in consequence of the phenomena presented by some forms of stricture being solely explicable in this way; their presence was first actually demonstrated by Kölliker and Hancock, who showed that the tube is surrounded through its entire length with an organic muscular coat. Hancock has demonstrated the course of these fibres. He has pointed out that the fibres of the inner layer of the muscular coat of the bladder pass forwards underneath the mucous membrane of the prostatic portion of the urethra, and those from the outer layer of the muscular coat of the bladder outside the prostate. These two layers join at the membranous portion of the urethra, forming the muscular covering of this portion of the canal. At the bulb, these two layers divide again; the inner lying underneath the mucous membrane, separated from it merely by areolar tissue; the external lying outside the corpus spongiosum, between it and its fibrous investment. At the anterior extremity of the urethra they unite again and form its lips. Thus the urethra is surrounded through its whole length by muscular fibres, a double layer of which invests it at the membranous portion, and again at the external meatus. The prostate and corpus spongiosum are included between planes of these fibres. The vesicles and ducts of the prostate are surrounded by layers of involuntary fibres; those of the ejaculatory ducts coming from the non-striated layer of the vas deferens. These fibres are totally distinct from the common muscular apparatus of the perinæum; and their existence proves the urethra to be a musculo-membranous canal.

By **Stricture of the Urethra** is meant a narrowing of the canal at one or more points. These may proceed from three distinct conditions; viz.—1, Spasmodic Action of the layer of the involuntary Muscular Fibres situated outside the mucous membrane; 2, Congestion of the Mucous Membrane of the canal; or, 3, Organic Changes in the Mucous and Submucous Tissues, consisting of thickening, induration, or the deposit of plastic matter within them. According as the disease arises from one or other of these causes, it may be termed a *Spasmodic*, a *Congestive*, or an *Organic* stricture. These different forms of the disease having the one condition—narrowing of the urethra—in common, and in practice being often associated, present so much variety in their symptoms, in the treatment they require, and the constitutions in which they occur, as to require separate description.

Spasmodic Stricture.—The existence of this form of constriction has been much cavilled at. Surgeons, disregarding the evidence of their own senses, and being led away by an imperfect anatomical examination of the urethra, have denied the possibility of spasm of this canal. The possession of muscular contractility by the urethra is, however, obvious from the facts that a bougie may occasionally be introduced with sufficient ease, but that the Surgeon, on attempting to withdraw it, will find it tightly grasped ; so, also, occasionally, on introducing the instrument, he will feel it meet with an obstruction, which on steady pressure will yield with that species of quivering that is peculiar to spasm of muscular fibre. Again, the fact that a patient will at one time pass his urine with the most perfect freedom, whilst, if it be rendered acrid or acid by drinking spirits, effervescent wines, or other similar beverages, almost complete obstruction will ensue, tends to prove the existence of an occasional spasmodic constriction of the canal. The effect of anæsthetics in facilitating the passage of a catheter must also be attributed to relaxation of spasm. These facts, though sufficiently convincing to many Surgeons, had failed to carry proof of the existence of spasmodic stricture to others, until the researches of Kölliker and Hancock, which have been referred to, set the question of the muscularity of the urethra finally at rest.

Causes.—The causes of spasmodic stricture are generally such conditions as occasion an irritable state of system, as long residence in hot climates, especially if conjoined with habitual excesses in drinking, high living and sexual indulgences. The more immediate causes are usually any circumstances that occasion irritation of the urethral mucous membrane, which, being propagated to the smooth muscular fibres beneath, calls them into activity, and thus gives rise to the spasmodic affection. The most usual of these are those conditions of the system in which the lithates are largely eliminated ; as exposure to cold and wet, by which the action of the skin is suspended ; or too free an indulgence in spirituous and acid liquors—such as red or effervescent wines, beer, or punch—which are well known to give rise to an attack in many constitutions.

Symptoms.—In spasmodic stricture we find evidence of narrowing of the urethra, and consequent impediment to the free flow of urine, rapidly supervening under the influence of certain causes, and as speedily subsiding. A patient, for instance, in his ordinary health and passing urine freely, if he take such food or drink as will give rise to a very acid condition of this fluid, if he be exposed to cold, or get out of health in any way, suddenly finds himself able to pass his urine only in a small stream by drops with much straining, or may even be seized with complete retention. Under appropriate treatment these symptoms rapidly subside ; recurring, however, on the application of any exciting cause. At the time of the occurrence of this spasm there is a sensation of weight and uneasiness in the perinæum, with evident irritation of the urethral mucous membrane, as shown by reddening of the lips of the orifice ; in fact, spasm alone without congestion or the presence of some organic narrowing will never cause actual retention.

Treatment.—If the patient be suffering from spasmodic difficulty in passing urine, an injection, consisting of half a drachm of laudanum in a little starch, should be thrown up the rectum, a morphia-suppository given, or a full dose of Dover's powder administered, and the warm hip-bath used. As the opium begins to take effect, the urine will usually be passed without much difficulty. The bowels should then be made to act, when the patient will usually be relieved. If the spasm continue, as it often does, for some days or weeks after this, a full-sized soft bougie should be introduced every second or third day, in order to lessen the irritability of the urethra. In some cases, this is more effectually done by the use of a plated bougie well warmed and oiled. Whatever instrument is used should be of large size, from No. 8 to 10. A small bougie will often be arrested, and will create much irritation, when a large one will pass readily. If the use of the instrument cause irritation and increase of spasm, it is better to omit it entirely, and to trust to constitutional treatment. But the Surgeon must not be discouraged, if the first few introductions of the bougie appear to increase the irritation ; as the urethra becomes accustomed to the use of the instrument, relaxation of the spasm will take place. At the same time, the patient's general health should be carefully attended to ; the bowels must be kept open, and the diet regulated ; all acids, stimulants, and sweets being carefully avoided. During the time when the bougie is being used, he should take the citrate of potash well diluted.

As a *preventive treatment* of these attacks, a careful regulation of the diet, warm clothing with the use of flannel, and keeping the skin in action by means of horsehair-gloves and tepid baths, will be found serviceable.

Congestive Stricture.—Many Surgeons look upon *spasmodic stricture* as essentially dependent on congestion of the mucous membrane of the urethra, overlooking altogether the existence of spasm, or considering it as the result of irritation of the perineal muscles, and not of the true organic muscles of the canal. That the two conditions of congestion and spasm are frequently associated in the urethra, in the relation of cause and effect, there can be no doubt ; and this is the most frequent condition in which spasmodic strictures are found. Indeed, congestion plays an important part in all forms of stricture ; it may, as we have just seen, be connected with the spasmodic variety ; it may occur alone ; or it may be associated with organic stricture. Some parts of the urethra appear to be more subject to congestion than others ; thus, for instance, the membranous and prostatic portions, especially the folds of mucous membrane constituting the verumontanum, are peculiarly liable to become congested.

Causes.—Congestive stricture frequently occurs as the result of chronic and long-continued inflammation of the urethra, or of the passage of urine that has been rendered irritating by being too concentrated, or by an admixture of an undue proportion of lithates. It is especially in gouty or rheumatic subjects who suffer from irritability of the skin and mucous membranes that this condition occurs. In these cases there is no true or permanent obstruction ; but the disease is transitory, and due solely to a swollen state of the membrane of the part. But in the majority of cases it complicates, and aggravates seriously, spasmodic and slight organic strictures.

Symptoms.—In congestive stricture we not only find the common symptoms occasioned by an impediment to the free passage of the urine, but some swelling of the lips of the urethra, with reddening and eversion of them. There is also slight gleety exudation, and not unfrequently an abundant puriform discharge, in fact, urethritis of a marked kind, with a sense of weight or fulness in the perinæum, pain in micturition, and sometimes uneasiness in defæcation. This state of things constitutes a very troublesome affection, intimately connected with the various forms of urethritis, and exceedingly apt to relapse from apparently very trivial circumstances, slight errors of diet, dyspeptic derangements, or any local sources of irritation.

The **Treatment** in these cases should consist in careful regulation of the diet and habits of life, and especially in the administration of the citrate of potash, and the saline aperient mineral waters, as those of Carlsbad or Friedrichshall. If there be much tenderness or weight about the perinæum, the application of leeches, together with the use of the warm hip-bath, will be serviceable.

Congestive stricture, though more influenced by constitutional than by local means in many cases, yet is often greatly relieved by the occasional introduction of bougies. In some instances a soft instrument, in others a silver, will be found to answer best. Whatever is used, care should be taken to introduce it slowly and with every possible gentleness. With all care, some hæmorrhage usually follows the passage of the instrument; not from deep laceration, but simply as the result of compression of the mucous membrane; and the discharge of blood appears to be beneficial rather than otherwise.

Organic Stricture.—This, the true form of stricture, is the result of the formation of dense fibroid tissue in the mucous membrane and submucous tissue of a portion of the urethra, in many cases extending to the neighbouring spongy tissue, or even further. This is produced as the result of chronic inflammation or of the healing of ulcers or wounds, and differs in no respect from the cicatricial fibroid tissue formed in other parts under similar circumstances. In its development it shows the tendency to contraction which forms the characteristic feature of all fibrous tissue produced as a consequence of inflammation, and thus leads to a narrowing of the canal it surrounds. The *causes of stricture* are, 1. Chronic inflammation of the mucous membrane, resulting from gonorrhœa. Repeated claps and long-continued gleets are by far the most fertile causes of this disease. The long continuance of the inflammation is more to be dreaded than its intensity in occasioning this mischief; hence it is of great importance not to allow gleets to run on indefinitely, as they will almost to a certainty be followed by constriction of some portion of the urethra. 2. The healing of an intra-urethral chancre always gives rise to a stricture. This is met with within an inch of the orifice, and is a comparatively rare form of the disease. 3. The most inveterate form of stricture arises from transverse laceration of the urethra from blows or kicks in the perinæum healing by a contracted scar. Severe contusions of other parts of the canal may in the same way cause narrowing of its calibre. A more rare cause is the injury done to the urethra of a child by the lodgment of a calculus, or in the effort to extract it. 4. S. Gross states that it may be caused by habitual masturbation.

Age.—Stricture of the urethra may be met with at any age after puberty. The causes that usually give rise to it seldom come into operation, however, before the adult age; hence strictures are not very common before 25 years of age. Between that period and the age of 40 they most commonly originate, and may then continue for an indefinite period. The earliest age at which I have seen true organic stricture of the urethra has been in a boy 14 years old, when it had already existed for more than 12 months; it was situated one and a half inch from the meatus, and was so tight as only to admit of No. 1 catheter. It was complicated with and had given rise to a fistula in perinæo, through which the greater part of the urine escaped. The boy in whom it occurred could give no explanation of its occurrence, but it was probably traumatic. His attention was first directed to it by a sudden attack of retention. The stricture was hard and gristly, about half an inch long, and required urethrotomy for its relief. There was no calculus.

Seat.—The seat of organic stricture varies considerably; indeed, any portion of the urethra may be affected by it, except the prostatic. It was at one time believed that the membranous portion of the canal was the most frequently affected by this disease. This, however, there can be little doubt, is an erroneous opinion. H. Smith has examined 98 specimens of stricture contained in the different London museums; of these he found only 21 seated in the membranous portion of the urethra, whilst 77 were anterior to the triangular ligament; the majority of these being either in the bulbous portion of the urethra, or a little in advance of this. Sir H. Thompson, in his excellent work on *Stricture*, states that, in an examination of 320 strictures, he found 215 at the junction of the spongy and membranous portions of the urethra; 51 in the spongy portion, from an inch in front of its commencement to within two inches and a half of the external meatus; and 54 at the external orifice, or within two inches and a half of it. The part most frequently affected is the first inch of the spongy portion; in the membranous portion, stricture is extremely rare, being almost invariably of traumatic origin when situated in this part. He says also, "I may confidently assert that there is not a single case of stricture in the prostatic portion of the urethra to be found in any one of the public museums of London, Edinburgh, or Paris." Occasionally strictures are multiple, two frequently occurring, and sometimes as many as four or five.

Pathological Appearances.—In describing the appearances commonly met with in a well-marked case of organic stricture, it will be most convenient to suppose that the whole canal has been laid open along its roof, and to consider the parts in the following order: 1. The part of the urethra anterior to the stricture. 2. The stricture. 3. The urethra behind the stricture. 4. The bladder. 5. The ureters and kidneys.

1. The **Urethra anterior to the Stricture** is perfectly healthy, unless it has been injured by instruments. If the cut edge of the mucous membrane be taken in a pair of forceps, it will be found to show a considerable degree of elasticity. Its colour is pink, and it is semi-transparent. The spaces of the spongy tissue beneath are empty and open, or filled with blood.

2. The **Stricture.**—At the narrowed part the surface of the mucous membrane is of an opaque white colour, marked by longitudinal ridges, and often parchment-like in appearance. If its edge be seized in the forceps it will be found to possess but little, if any, elasticity, and to be firmly fixed to the parts beneath. The submucous tissue, instead of forming a delicate areolar layer, is represented by tough rigid fibroid tissue firmly adherent on one side to the mucous membrane, and blending on the other with the cavernous tissue of the corpus spongiosum. The spaces of the spongy tissue are, in all more advanced specimens, obliterated for a greater or less extent near the stricture, so that the corpus spongiosum at this spot is converted into a dense solid mass. In very extreme cases the chronic inflammatory induration extends even to the areolar

tissue beyond. The character of the stricture varies greatly. In some cases it is annular, encircling the whole canal equally for some little distance. When it is elongated, there is usually marked consolidation of the corpus spongiosum, as in Fig. 945. In other cases, again, annular strictures may be narrow and sharp-edged, and are then called "pack-thread" or "bridle" strictures; consisting of bands stretching across the urethra (Fig. 946). Sometimes there are several of these in close proximity to one another, leaving merely narrow passages between or under them. These bands occasionally stretch directly across the canal, but more commonly they take a somewhat oblique direction (Fig. 947). It is not very clear how these bridles or fræna stretching across the urethra are formed. It can scarcely be by inflammatory exudation; it is more probable that they are occasioned by perforation of an annular narrowing of the mucous membrane by the point of the catheter. These various kinds of organic stricture are hard and elastic; sometimes, when old, almost cartilaginous in their density, feeling gristly and rough to the instrument that passes over them.

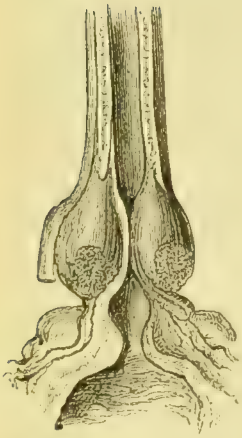


Fig. 945.—Stricture from Consolidation of Corpus Spongiosum.

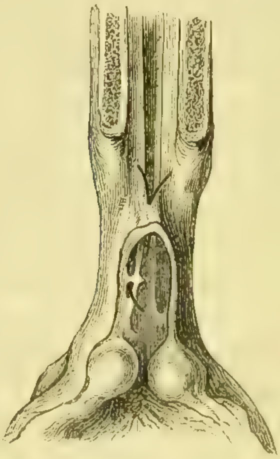


Fig. 946.—Bridle-stricture.

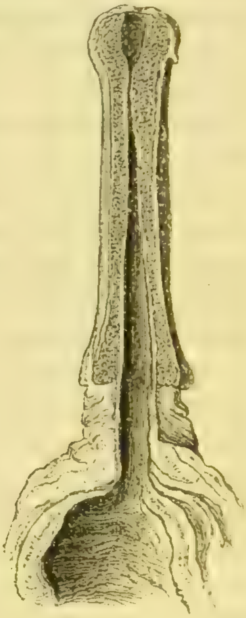


Fig. 947.—Stricture at the Anterior part of the Urethra.

The *Amount of Constriction* varies greatly in organic stricture, from slight narrowing of the channel to almost complete obstruction of it. A question has arisen whether the canal of the urethra is ever rendered completely impermeable by a stricture. In answering this, it is necessary to be agreed upon the meaning of the term "impermeable." If by it be meant impenetrable to the passage of a catheter, there can be no doubt that such strictures may occasionally, though very rarely, occur; the channel being so narrow, oblique, or tortuous, that the instrument cannot be passed through it. Strictures, however, of this description may usually be ultimately made permeable to instruments by proper and careful treatment. If by "impermeable" is meant generally impervious to the passage of urine, there can be no doubt that such a condition does not exist. It would clearly be incompatible with life, unless a fistulous opening existed behind the stricture, through which the urine might pass out ; and, even with such an aperture existing, I have never heard of or seen a case in which no urine whatever escaped by the meatus, unless, in consequence of injury or disease, a portion of the whole calibre of the urethra had sloughed away ; and it is clear that, so long as any urine passes out in this way, a stricture cannot be looked upon as truly impermeable.

3. The **Urethra behind the Stricture** is dilated often, so as to form a considerable pouch, on which in rare cases phosphatic concretions may form. The mucous membrane is more opaque than natural, and its loss of elasticity is indicated by its being thrown into longitudinal folds ; it is usually of an ash-grey colour, indicating that it has suffered from chronic congestion or inflammation. The orifices of the lacunæ, and of the small glands opening upon it are dilated often to a considerable size. This is also very marked in the floor of the prostatic urethra. These small pits and hollows often cause considerable embarrassment in treatment, the instrument lodging in them after having safely passed the stricture. The cause of these changes is the extreme tension this part of the urethra is exposed to during micturition owing to the obstruction in front, and the powerful hypertrophied bladder behind.

4. The **Bladder** in all well-marked cases of stricture shows evidence of chronic cystitis. Its mucous membrane is thickened, rigid, and of an ash-grey colour. If from any cause the condition has been aggravated before death, dark-red and purple patches will be found upon it. As a rule the cavity of the bladder is diminished, and its muscular coat greatly hypertrophied, giving rise to marked fasciculation of its inner surface. In exceptional cases, especially in old men, it may be dilated as well as thickened ; sacculi are very common.

5. The **Ureters** are often more or less dilated. This is not, as was formerly supposed, due to regurgitation of urine, but to obstruction to the orifice of the ureter by the chronic inflammation of the mucous membrane, and the hypertrophy of the muscular coat of the bladder ; the force that dilates the ureter being the force of secretion from the kidney. The further changes that occur in the pelvis and in the kidneys are fully described in Chapter LXVI.

Symptoms.—The amount of **constitutional disturbance** set up by a stricture will vary greatly in different cases. In many, and indeed in most instances, it is not very great. The extent to which the constitution is influenced will generally be in proportion to the tightness and duration of the stricture ; but it is surprising how much constitutional irritation is set up in some systems by a stricture, even though it be not very tight. The interference with the free flow of urine ultimately causes secondary mischief in the kidney, the nature and the symptoms of which have been described in Chapter LXVI., to which I must refer the reader. In some cases the constitutional symptoms are rather of a nervous character ; the patient suffering not only great pain in micturition, but being seized with rigors, followed by prostration, each time the urine flows over the tender and irritable surface.

The **Local Signs** of stricture are always well-marked, are unequivocal, and are dependent simply on the mechanical obstacle presented by the contracted urethra to the free escape of the urine. The disease usually commences with the retention in the urethra of a few drops of urine after evacuation of the contents of the bladder ; these escape and wet the clothes. The patient finds that he has to pass urine more frequently than usual, both by night and day ; there is some straining, perhaps a slight gleety discharge, and a feeling of weakness about the genital organs. The stream of urine has changes impressed upon it during its passage through the stricture, by which its shape and direction are modified ; thus, it may become forked, scattered, twisted, fan-like, or be discharged in a double current—one projected directly forwards, the other dropping perpendicularly downwards. There is usually but little pain in micturition, and such as there is occurs during this act, and ceases as soon as it is completed. As the disease advances, these signs necessarily become more marked, until they may terminate in complete retention ; they, however, often come on in a very insidious manner, and when the patient seeks advice he is found to be already the subject of a very tight and intractable stricture ; indeed, in some cases, the first circumstance that directs the attention of the patient to his complaint is the sudden occurrence of retention of urine.

Examination of the Patient for Stricture.—In all cases of suspected stricture, the Surgeon should, if possible, see the patient pass water before using an instrument. He will thus be able to judge of the actual amount of obstruction. It sometimes happens that the canal, though not greatly narrowed, is tortuous and indurated, so that an instrument enters with great difficulty, although the patient passes a fair stream of urine. Such a case might readily be mistaken for a very tight stricture if the examination were commenced by attempting to pass an instrument. The existence of a stricture can however be determined with certainty only by the introduction of an instrument. In exploring the canal in a suspected case, two points have to be ascertained, the existence of a stricture, and its degree of tightness.

The *Existence of a Stricture* is best determined by passing a soft conical French bougie about No. 8 (English scale). It must be slightly warmed and well oiled. This will pass readily, unless the canal be distinctly constricted, when it will be arrested at the narrow point. In this exploration, too small an instrument must not be used, lest it hitch in the fossæ of the urethra or against the verumontanum, and this accidental arrest be mistaken for the obstruction produced by a stricture ; or it may pass through the stricture, and thus mislead the Surgeon. The existence of a stricture having been ascertained, the next point is to determine its *degree of tightness*. This is best done by withdrawing the instrument previously used, and then introducing a smaller one about the size of the stream of urine that the patient passes. If this fail to enter the stricture, a still smaller one must be used, until that size is reached, which can be introduced with but a moderate degree of force. In this way the existence, the seat, and degree of tightness of the stricture, are ascertained.

A soft instrument should always be used by preference for this preliminary examination, as it causes less pain, and with the most ordinary skill and care it is impossible to do the patient any injury with it. There is no doubt that information as to the length, degree of induration, and form of the narrowing, may be gained by the experienced Surgeon by means of a metal bougie ; but the knowledge thus gained is not sufficient to counter-balance the greater ease and safety of a soft instrument.

The slighter narrowings of the urethra are not easily recognized by the means just described. For this purpose the conical or olive-headed bougie (Figs. 948 and 949) will be found most useful. The conical shape of this instrument enables it to pass readily towards the bladder, but on withdrawing it the shoulder hitches on any narrow part. The instrument should be graduated in inches, so that the exact distance of the stricture from the orifice can be readily determined. If it be desired to determine more accurately the seat of the stricture, the distance of the orifice of the bladder from the meatus externus must first be determined by carefully passing a graduated "catheter *à boule*," and noting the exact moment at which the urine commences to flow. The graduated olive-headed sound is then passed, and slowly withdrawn. If the hitch or cling be felt between one inch and one and three-quarters, the stricture is in the membranous part. If between one and three-quarters and three inches, it is in the bulbous portion. For the purpose of measuring these slight strictures, Otis, of New York, has invented an instrument which he calls the "urethrometer" (Fig. 950). It consists of a straight tube, the end of which can be dilated into a sort of fenestrated sphere, and the size to which it is dilated is registered on a small dial on the handle. The instrument can be readily introduced into the bladder, if necessary, but there is no advantage in so doing. When in the urethra, behind the stricture, the bulb is gradually expanded till it is just held, but not tightly grasped. It is then drawn steadily forward, and when it is stopped the bulb is gradually diminished till it passes the stricture. The exact size of each part is thus registered on the dial.

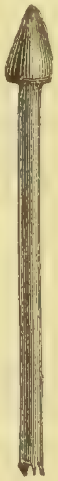


Fig. 948.—Conical-headed Sound.

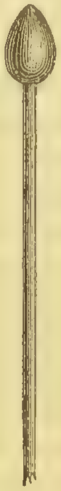


Fig. 949.—Olive-headed Sound.

The employment of soft wax bougies has been recommended with the view of taking a mould of the size, shape, and direction of the stricture, by pressing the end of the instrument into it; but no possible advantage can be derived from this proceeding, and a Surgeon accustomed to the use of metallic instruments can obtain all this information with more certainty by the finer touch afforded by them.

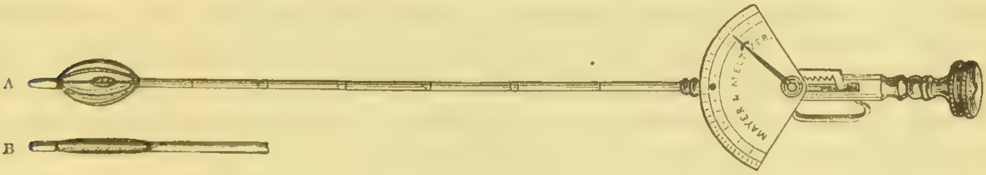


Fig. 950.—Otis's Urethrometer. A Open; B. End closed.

Treatment.—The treatment of organic stricture of the urethra may be conducted by the following methods :—1, Gradual Mechanical Dilatation ; 2, Continuous Dilatation ; 3, Caustics ; 4, Electrolysis ; 5, Forcible Expansion or Rupture ; 6, Internal Urethrotomy ; 7, External Urethrotomy or Perinæal Section. Whatever plan of treatment be adopted, the Surgeon must bear in mind that his operations have to be conducted upon a tender canal endowed with exquisite sensibility, which sympathizes closely with the conditions of the general system, and in which improper violence or too active measures may set up a degree of irritation that will readily extend to neighbouring structures, and thus jeopardize the life of the patient. But, though it is necessary to recollect all this, he must not run into the opposite and equally dangerous extreme of adopting inefficient measures for the removal of the obstruction. A bad stricture is one of the most serious diseases to which the human frame is liable, and will almost inevitably, if left to itself, terminate fatally by the induction of renal disease, or of serious local complications. We must therefore not hesitate to adopt sufficiently energetic measures for its removal; and if these be properly conducted, there is scarcely any affection in which the Surgeon can afford his patient greater relief than in this. At the same time, however, that local means are being used, constitutional treatment should not be neglected. Organic stricture is often more or less associated with a spasmodic or a congestive condition of the urethra, and requires the same constitutional treatment, modified according to circumstances, that is necessary in these affections —proper regulation of diet, avoidance of all articles of food that generate lithates, and care not to allow the urine to become too concentrated. Attention to the maintenance of the healthy action of the liver and skin will also tend much to increase the patient's comfort, and to ward off the more serious consequences of stricture.

In all except the slightest cases of stricture it is advisable, before beginning mechanical treatment, to subject the patient to constitutional remedies to diminish as far as possible the congestion and spasm which may be present. If any serious difficulty be anticipated, and if the circumstances of the patient permit it, he should be confined to bed for a day or more. The bowels should be freely opened, and he should sit for some time in a hot hip-bath, morning and evening. An opium or morphia suppository may be administered at night, and if the signs of congestion be well marked, a few leeches may be applied to the perinæum. Occasionally blisters over the seat of stricture, when it can be clearly felt from without, may be of service. By these means alone, a stricture which at first seemed almost impermeable may be so far relieved as to take a No. 4 or 5 catheter.

1. **Gradual Mechanical Dilatation**, as it is erroneously termed, is the usual and certainly the most successful mode of treating ordinary strictures; but it is not the mere stretching or forcible dilatation of the stricture that cures it. The means employed to produce dilatation tend to promote the absorption of chronic inflammatory products in and underneath the mucous membrane, which especially constitute the stricture.

The instruments that are used for dilatation are either metallic, such as silver catheters, steel sounds, or plated bougies; or made of some soft and yielding material, as gum-elastic catheters, catgut, whalebone, or elastic bougies. Though each Surgeon will mostly prefer one kind of instrument to another, it is well not to be too exclusive in the use of any one; for it will be found in particular strictures and certain constitutions that it is advantageous to depart from the ordinary practice, and that the Surgeon may modify with great benefit to his patient the mechanical means that he adopts. As a general rule if the stricture can be treated from the first by soft instruments, so much the better. They cause less pain and irritation, and the danger of making false passages is avoided. When the stricture is tight, cartilaginous and of old standing, it is, however, frequently impossible to pass any soft instrument through it, and then a well-made steel bougie or a silver catheter must be used. When once dilatation has been carried to a certain point, for instance to the introduction of a No. 5 catheter, then soft instruments can always be employed if preferred ; but at this stage of the treatment when the risk of making a false passage is very small, conical steel bougies will in many cases be found not only more efficient but quite as comfortable to the patient.

The best soft instruments are the conical bougies and catheters with *bulbous ends* (Figs. 951 and 952). Their introduction excites far less irritation and pain, with much less likelihood of bleeding from a congested mucous membrane, than does that of metallic or even gum-elastic instruments. In most cases of ordinary stricture they will be found to be the safest and most agreeable instruments to use. They will often glide through a tight irritable stricture, when all other instruments, especially metallic ones, fail to pass.

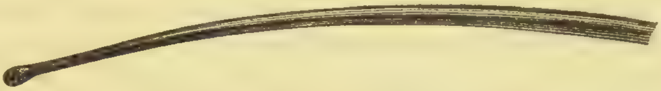


Fig. 951.—Conical Bulbous Bougie.

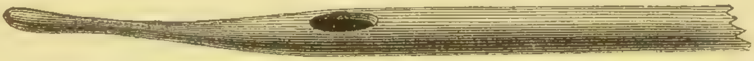


Fig. 952.—Conical Bulbous Catheter.

A *filiform bougie* made of whalebone, gum-elastic or catgut, may sometimes be passed through a very narrow stricture, when every other instrument fails to do so. The ordinary English gum-elastic catheter is of little use in the treatment of stricture by simple dilatation. A conical instrument, the point of which is small enough to pass readily through the stricture, can easily be pushed on so as to exert considerable dilating force with its thickest part. An ordinary English gum-elastic which is the same size throughout cannot be got into the stricture at all so as to exert any dilating force, as it is not stiff enough to be forced into it. If a stylet be used to stiffen it, it becomes as capable of making a false passage as a steel bougie, and is not under the same control.

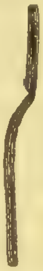


Fig. 953. — Catgut Bougie bent to shape of Stricture.

If the stricture be not only very tight, but twisted, the plan recommended by Brodie may be advantageously employed. This consists in taking a fine catgut bougie, and bending it, as represented in Fig. 953, about an inch from the point, so as to follow the track of the stricture. In this way, strictures that are otherwise impassable may be rendered pervious with comparative ease.

If metal instruments are used the most efficient are *conical steel bougies* or sounds as they are often called. The best curve for these instruments, I think, consists of one-fourth of the circumference of a circle 4½ inches in diameter. There should be a difference of three sizes between the point and the thickest part, which corresponds to the bend of the instrument. The point should be well rounded, and the instrument passes more readily if there is a slight constriction immediately beyond it. The instrument should be made of nickel-plated steel and be highly polished. It should have a broad metallic handle, which transmits any sensation communicated to the point more readily than a wooden one. That this instrument will pass much more easily than a catheter is self-evident, and the latter should be used only when it is intended to tie it in. If a catheter be used it should be made very solid and stiff. The rings should be large, so as to serve for a handle, and the eyes well rounded off and somewhat depressed, so that they may not scrape the urethra. These instruments should be used with every possible care and gentleness; but, though no one recognizes more strongly than I do the necessity of not employing unnecessary violence in their introduction, it is useless to think of passing a catheter through a tight hard stricture without the employment of some degree of force. The catheter will not "find its own way" here as it may in a healthy urethra, but it must be guided and directed by the hand of the Surgeon; and there is scarcely an operation in surgery that requires more tact and delicacy of manipulation than that of passing an instrument through a tight stricture. Here some force must be used, but the skill is shown in proportioning this to the amount of resistance, and in using it in a proper direction. The appearance of force is indeed often greater than the reality; for, though the point of the catheter have passed a tight stricture, it may still require considerable pressure to push the rest of the instrument through it. With a conical steel bougie less force is required than with the catheter, as the stretching is not done with the point which should pass easily through the stricture, but with the expanded part beyond, which from its conical form passes without much difficulty.

Introduction.—Catheters and sounds are best introduced by laying the patient flat upon his back, with the pelvis somewhat raised, and the head and shoulders low. The Surgeon, standing on the left side, inserts the instrument, well-warmed and oiled with "Lund's oil" or vaseline, into the urethra, with its concavity turned towards the left groin, and passes it down the canal, at the same time drawing the penis upwards with his left hand, so as to put the mucous membrane on the stretch. As the instrument approaches the triangular ligament, the handle is carried to the mesial line, and at the same time raised perpendicularly; and, as its point passes under the pubes, it should be kept well against the upper surface of the urethra, and made to enter the bladder by depressing the handle towards and between the thighs. The surest guide to the bladder is the upper surface of the urethra, which is more fixed than the lower, and less liable to the existence of fistulous openings or false passages. Should difficulty be experienced, the introduction may be facilitated by injecting and slightly distending the urethra with olive oil before passing the instrument.

If difficulty is found in introducing the instrument, and if any doubt exist as to its being in the right passage, the finger must be introduced into the rectum and its position felt for. If the point of the instrument has left the urethra this may be recognized by its being too thinly covered and too near the gut, or by its being out of the middle line.

Chloroform or ether need be administered only if the stricture be very tight or the patient irritable. Under the influence of an anæsthetic, however, many strictures may be readily passed with metallic instruments that are not pervious in any other way.

Results of Introduction of an Instrument.—The introduction of an instrument usually gives rise to a smarting, painful sensation in the urethra; this is generally most severe as the point approaches the neck of the bladder, and is then sometimes attended by nausea and sudden faintness. As a general rule, the instrument should be passed every second or third day, and when introduced should be left in for about five minutes, or until the spasm of the urethra induced by its introduction has subsided. If, however, the stricture be extremely tight, a very small catheter only having been introduced, the instrument may be left in for twenty-four or forty-eight hours, when it will be found that, however tightly grasped it had been originally, it has become loosened; a slight discharge being at the same time set up from the urethra. It may then be readily withdrawn, and, when the irritation has subsided at the end of a couple of days, a considerably larger one may be introduced.

The augmentation of the size of the instrument should be very gradual. It is fully sufficient to increase it by one number at each time of introduction. Many urethræ will not bear even this, and it becomes necessary to pass the same instrument on two or three successive occasions before a larger size can be introduced. The size of the instrument may be gradually increased until the largest is reached which the urethral orifice readily admits; beyond this, the Surgeon should not go; but as soon as the full size, usually No. 12 or 14, can be introduced with ease, it should not be passed so frequently as before; once a week or ten days, and gradually with less frequency. But a patient who has once suffered from a tight stricture should pass an instrument at least once a month for the rest of his life.

If the size of the instrument be increased too rapidly, irritation may be set up, and inflammation of the testicles, and abscess in the perinæum or prostate, induced. I have more than once had occasion to regret being in too much haste to increase the size of the instrument; and, by augmenting it by two or three numbers at one sitting, have seen the patient thrown back for weeks by the supervention of some of the affections just mentioned.

By gradual dilatation, properly carried out, most strictures may be considerably relieved in the course of a few weeks; and the majority may be brought to the full size by continuing the treatment for a sufficient length of time. Some, however, cannot be cured in this way; it would appear that the tissue of which they are composed is so rigid that, although they may be expanded up to a certain size—say up to No. 5 or 6—it is impossible to go beyond this. In other cases there is a great tendency to relapse, and to a return of the constriction; the stricture rapidly becoming tighter as soon as the introduction of the instruments is discontinued, even though it be dilated to the full size of the urethra, up to No. 12 catheter, for instance. In some instances the relapse is almost instantaneous, micturition being as difficult as before immediately the catheter is withdrawn. In these cases recourse must be had to other measures, which will be described.

Accidents attending Catheterism.—The introduction of instruments occasionally gives rise to certain troublesome and even dangerous sequences. Amongst these, syncope and rigors, hæmorrhage, and inflammatory irritation about the urethra or testes, are the most common.

Nervous Symptoms, Rigors, and Urethral Fever.—The subject of urethral fever following the use of instruments on the urinary organs in persons affected with chronic subacute interstitial nephritis has already been discussed at p. 968. There is no class of cases in which this untoward complication is more apt to occur than in the treatment of stricture of the urethra, owing no doubt in a great degree to the frequency of the occurrence of chronic and possibly unsuspected kidney disease in old cases of stricture.

Various degrees of constitutional disturbance may be produced by the passage of an instrument through a stricture. In nervous and sensitive individuals this operation is often attended by a sensation of faintness and chilliness as the instrument enters the bulb or membranous portion of the urethra. This sensation is not due either to pain or to fear. It is purely reflex, and in most cases soon passes off, being less liable to recur as the urethra gets more accustomed to the use of instruments.

If a person liable to these nervous feelings is exposed to a chill, a severe rigor may come on some hours after the passage of the instrument, or the same occurrence may happen when there has been no predisposition to it, the rigor coming on suddenly and without warning. This is more apt to happen when the stricture is tight; when metallic instruments have been used—possibly with some degree of force, and, though during a considerable length of time—perhaps in vain attempts to penetrate the stricture. The rigors in these circumstances are very severe, so much so as to resemble an attack of ague. During the rigor the temperature rises considerably, often to 104° or 105°. The subsidence of the rigor is marked by profuse sweating, and is usually attended by great exhaustion. This occurrence is always very alarming, and, though usually not attended by positive danger, leaves the patient weak and exhausted; and if he be old, of broken constitution, or the subject of chronic kidney-disease, a fatal result may rapidly ensue. In these distressing cases, death may occur at different periods and in different ways. The earliest period at which I have seen a fatal termination has been in nine hours; usually it takes place in from 24 to 48 hours after the first rigor. The immediate cause of death may be coma, exhaustion, or cardiac syncope.

The cause of these rigors is exceedingly obscure. Constitutional nervousness or timidity has certainly nothing to do with them. They occur in the strongest and most courageous men, and they very rarely follow the use of the catheter in women. I have only once seen these effects in the female, in the person of a young married lady, strong and healthy, who had a stricture of the orifice of the urethra, which I dilated by a two-bladed dilator. Twenty hours after the operation, she had three most intense rigors followed by profuse sweatings. In men they may occur after dilatation of any part of the urethra, but are much more frequent when the stricture is seated in the bulb or in the membranous portion of the canal. I have, however, heard of one case in which a fatal rigor followed incision and dilatation of the orifice of the urethra. I doubt whether severe rigors occur unless there have been some traumatic lesion, such as abrasion or rupture of the mucous membrane of the urethra. Rigors certainly follow the use of metallic instruments more frequently than that of the softer kinds, which are less likely to produce such mischief. Rigors are not prevented by the use of anæsthetics. Some of the worst cases that I have seen have occurred after prolonged instrumentation under anæsthetics.

Treatment.—The rigor is best prevented by gentleness in the use of instruments; by the employment of soft, rather than metallic ones; by guarding most carefully against a chill, the patient being kept in a warm room during the whole of the day ; and by the administration of a full dose of opium and quinine before the use of the instrument.

When a rigor has set in, the patient should be wrapped up in blankets ; a glass of hot spirits and water or tea may be given, to be followed up by quinine and opium. The sweating, which is often so profuse as to wet through pillows and bed-clothes, must be encouraged. When it has ceased, the patient should be rubbed dry and laid in dry warm blankets.

Suppression of Urine is a rare accident after simple dilatation, being more common after the more severe methods of treatment, such as forcible dilatation. The symptoms are at first those just described, the patient suffering from a rigor, with rapid elevation of temperature, dry skin, and vomiting. The secretion of urine entirely ceases, or at most a few drops darkly-stained with blood escape. The patient usually dies in from two to three days, unless the secretion returns. In these cases the kidneys are usually found more or less extensively affected with chronic interstitial inflammation ; but cases have been recorded in which the microscope revealed but little change. They are usually gorged with blood. The condition would seem to arise from reflex nervous disturbance of the kidney, but the exact pathology of the process is very obscure. The *Treatment* consists in dry cupping over the loins and hot-air baths. Large warm water enemata, with a view of "fomenting the kidneys," have been suggested. The bowels must be freely opened by a compound jalap powder. Possibly in some cases pilocarpine hypodermically in doses of from $\frac{1}{10}$ to $\frac{1}{4}$ of a grain might be of use.

Hæmorrhage, which is sometimes rather profuse, may follow the introduction of a catheter, especially if the stricture be congestive, and the instrument employed small. It generally ceases of itself ; but, if it be troublesome, the application of cold will check it.

The **Inflammation** about the urethra and in the testes that occasionally occurs during the treatment of stricture, is best guarded against by not using too large catheters, and by directing the patient to abstain from much exercise during the time of their introduction.

False Passages are occasioned by the instrument passing out of the urethra through its coats into the surrounding tissues. They are especially apt to occur in tight bridle-strictures, when a small instrument is being used, and more especially if the direction of the constriction be somewhat oblique, so that the point of the sound is thrown against the side of the canal (Fig. 946). The extent and situation of a false passage necessarily vary according to the position of the stricture ; and the danger is usually in proportion to its depth. The false passage usually takes a direction downwards and to one side of the urethra. If the stricture be far forward, it may run in the corpus spongiosum ; but if it be in the usual situation, it may perforate the lateral lobe of the prostate, or run between this and the rectum, being unable to extend upwards on account of the rigid nature of the structures in this situation. When the false passage merely perforates the corpus spongiosum, running parallel to the urethra, and opening again into the canal, or when, perforating a portion of the prostate, it enters the bladder, it is not necessarily attended with much danger ; but when it enters the areolar tissue between the bladder and the rectum, breaking up this structure to a great extent, admitting urine into the recto-vesical space and about the neck of the bladder, then the most serious consequences, such as inflammation and abscess in this neighbourhood, are apt to ensue, which may be followed by the death of the patient.

At the moment when a false passage is made during the introduction of an instrument, by the Surgeon using too much force or pressing in the wrong direction, he feels the point make a sudden slip, which the plane of the handle shews to be to one side of the urethra. The patient complains of severe pain, and is often conscious of a laceration ; there is a grating or rough sensation communicated by the tissues against which the instrument has passed ; and though it have entered deeply, it will be found not to have reached the bladder. On the Surgeon introducing his finger into the rectum, he probably feels the point of the instrument in the areolar tissue between the gut and the bladder ; on withdrawing it, it will be found covered with blood, and there will be free hæmorrhage from the urethra.

The Surgeon knows when he has entered an old false passage by the change that takes place in the direction of the instrument, by its not reaching the bladder and by the rough sensation communicated to it, very different from that afforded by the smooth lining of the urethra. The patient is often conscious of the existence and of the entry of the instrument into the false passage, and will warn the Surgeon of it.

If the Surgeon be aware that he has made a false passage, he should, if possible, at the time of the accident pass a catheter into the bladder, and leave it there for a few days until the laceration has healed. If there be an old false passage he must be careful, by keeping the point of the instrument away from it, not to enter it, lest during the introduction of the catheter he raise with the point of the instrument the valvular angle that intervenes between it and the urethra ; every time that this is opened up it tends to lessen the chance of closure of the aperture, whilst, overlapping the urethra, it interferes with the onward passage of the instrument into the bladder. By withdrawing the instrument and changing its direction, the false passage may often be avoided, and the bladder reached. Should there have been much difficulty in introducing the catheter, the better plan will be to allow it to remain in for two or three days, when the false canal may possibly close.

It has already been stated that, in certain forms of stricture, gradual dilatation does not succeed in effecting a permanent cure. In these cases five plans of treatment have been recommended—continuous dilatation, the destruction of the stricture by caustic, electrolysis, forcible dilatation, and its division by the knife. These methods will now be described.

2. **Continuous Dilatation** is merely a modification of the preceding mode of treatment, and is useful only in very tight organic strictures. A small instrument is first passed and tied in. In tying the catheter in, care should be taken that it does not lie too far in the bladder. It should be pushed backwards and forwards until the exact point is found at which the eye is inside sufficiently to allow the water to flow, and be fixed at this point. It is best retained by soft thick silk tied round the corona of the glans, or fixed to the body of the penis by a piece of plaster, care of course being taken not to produce strangulation. In from twelve to twenty-four hours, although it may at first have been tightly grasped, the catheter will be found to be quite loose, and urine will escape beside it. It must now be changed for a larger one. In doing this, the fresh instrument should be ready, so that the moment one is removed the other may be introduced. A neglect of this precaution, especially

when false passages are present, may seriously increase the difficulty of passing the fresh catheter. By the second day a slight discharge will be found to have been set up from the urethra. The treatment should be continued till the urethra reaches the size of No. 5 or 6, which it will do in a few days at most, after which it is not necessary. The catheter may be closed with a small wooden plug, so that the patient can draw off his own urine, or, better still, an india-rubber tube may be attached so as to drain the bladder. In cases in which a gum-elastic catheter cannot be passed, a small silver one may be tied in, and replaced by a gum-elastic at the first change. When nothing but a filiform whalebone- or catgut-bougie has been passed, it may still be tied in, as the urine will usually find its way beside it even when it seems at first to be tightly grasped; and in twelve hours or a little longer it may, in most cases, be changed for a fine gum-elastic catheter. This plan of treatment is of great use in cases in which considerable difficulty is found in introducing the instrument, but it has the disadvantage of being extremely liable to set up cystitis. If the treatment be continued beyond three days, the urine will almost always be found to be alkaline; and this is scarcely to be wondered at when we consider the way in which the bladder is, as it were, opened up to the air. The risk of cystitis is much diminished by draining the bladder, for then no urine is left to decompose, and the mere contact of the soft instrument with the walls of the bladder seems to cause but little irritation by itself. In rare cases, sloughing of the urethra may take place at the seat of stricture, leading to perineal abscess. A case of this kind occurred not long ago in University College Hospital.

3. **Caustics.**—In the treatment of stricture by caustics, two objects are aimed at; the first is the destruction of the stricture; the second, the diminution of the sensibility of the surrounding mucous membrane, so that the irritability and spasm of the canal may be lessened. The following is the way in which the caustic is applied. A wax bougie, well oiled, is passed down to, but not through the stricture; the Surgeon then, with the thumb-nail, makes a notch on that portion of the instrument opposite to the meatus. Another bougie of similar length and size is then armed with a piece of potassa fusa about the size of a small pin's head, placed in a depression at its end. A mark is made on it, at a point corresponding to the notch on the first bougie, and it is then passed rapidly down until this mark comes opposite to the meatus, and pressed firmly for two or three minutes against the stricture, upon which the caustic exercises its action. This application, which is followed by a gleety discharge, is to be repeated every second or third day until a bougie of proper size can be introduced; and then the dilatation may be proceeded with in the usual way. This practice, stigmatized, not unjustly, by Liston as "most atrocious," has now but few advocates; and, indeed, there appears to be nothing useful effected by it, beyond what can be accomplished much more safely and easily by a catheter or sound in an ordinary skilful hand.

4. **Electrolysis.**—The cure of a stricture by destroying the fibroid tissue which narrows the urethra, by electrolysis, was introduced by Mallez and Tripier, more than fifteen years ago, but did not find much favour. Its results were uncertain, and in some cases it was followed by perinæal abscess and other complications. It has lately been revived by Newman of New York, and has been practised in this country by Bruce Clarke, Edwards and others. The operation consists in passing the negative electrode, which is like an ordinary

soft catheter with a metal tip down to the stricture, and placing the positive, which must have a large flat pad, on some part of the body, as the back. The current should be one of from $2\frac{1}{2}$ to 5 milliampères. The electrode is held gently against the stricture, and after a period varying from two minutes to half an hour, it will be found to have passed through. The operation should give little or no pain. It requires to be repeated two or three times, a larger electrode being used on each occasion. Newman, who is the chief advocate of this treatment, asserts that he has operated on two hundred cases without an accident and without a relapse. It is asserted that the current used in this way does not actually cauterise. This method of treatment is again on its trial. That it is not more dangerous than other modes of treatment and that by it the canal may be restored to its normal size, seems to be tolerably clearly proved, but better evidence is wanted than has as yet been furnished that it effects a permanent cure without any tendency to a relapse. If it can do this, it stands alone amongst all methods of treating stricture.

5. **Forcible Expansion or Rupture.**—Forcible and rapid dilatation causing the expansion and rupture of the stricture, is a method that, originally proposed and practised many years since by Luxmoor, Arnott, and Buchanan of Glasgow, has of late years been revived, and ingeniously modified in detail, by many Surgeons, amongst whom Reybard, Maisonneuve, Perrève, Wakley, Holt, Thompson, and Hill are the most conspicuous. However varied the means by which strictures are thus treated, the instruments employed may be arranged in three groups : *a.* Those that act as sliding tubes ; *b.* Those that expand by a screw mechanism ; and *c.* Those that act on the principle of a wedge. It may also be effected by the passage of the conical steel bougies already described, one after another, while the patient is under an anæsthetic, though this method is perhaps more properly included under simple dilatation.

a. **Sliding Tubes** were first employed in the treatment of stricture by Desault at the close of the last century, subsequently by various French Surgeons, and in later years by Hutton of Dublin, and very extensively and successfully by Wakley. The mode of application of these tubes is as follows. A long conductor is introduced through the stricture into the bladder, and over this a catheter, either of gum or silver, is passed, which in its turn is made to serve as a conductor to a larger one. In Wakley's instrument the conductor, or "urethral guide," consists of a small silver catheter, which, after being passed through the stricture, has a long steel rod screwed into it. Over this a silver tube is passed, which in its turn is made to serve as a conductor ; and thus the stricture may be rapidly dilated by passing one tube over another until a full size is reached. The only difficulty in this very ingenious method—which is, however, common to it and every other plan of treating stricture by dilatation—consists in the first introduction of the "urethral guide ;" when that has once passed through the stricture, the tubes must follow as a matter of necessity. They cannot possibly go wrong ; and, as no laceration of the stricture is, or can be, effected by the instrument, it appears to be a safe means of employing rapid dilatation.

b. The method of forcibly expanding a stricture by the introduction into it of a small two- or four-bladed instrument, fashioned somewhat like a narrow beaked sound, and which, by **Screw-Mechanism** in the handle, admits of being opened out so as to stretch the stricture to an extent corresponding to the distance at which the blades are screwed apart, has many advocates; and various ingenious contrivances have been invented to effect this object. More than half a century ago, Luxmoor attempted it by the use of a four-bladed instrument. Some years later Civiale invented a stricture-expander; and subsequently two-bladed instruments, having this end in view, have been introduced into practice by Perrève, Lyon, and Sir H. Thompson. The accompanying drawing (Fig. 954) is a representation of the instrument used by the last named Surgeon; it answers the intended purpose admirably, the expansion of the blades being effected by a screw worked by turning the handle. This should be done very slowly, several seconds being allowed to elapse between each turn of the handle, so that the tissue composing the stricture may be gradually stretched, and the canal of the urethra at the seat of stricture dilated beyond the full size, so as to be over-stretched; the extent of dilatation may be carried up to 16 or 18, and is marked on a scale attached to the handle of the instrument. If this operation be done slowly, little if any bleeding results, and there is no evidence of deep laceration of the wall of the urethra at the strictured spot. A large gum-elastic catheter may then be passed, and the urine drawn off. It is not usually necessary to leave the catheter in the bladder, though there can be no objection to doing this for forty-eight hours, after which the patient may have one passed occasionally in order to maintain the dilatation.

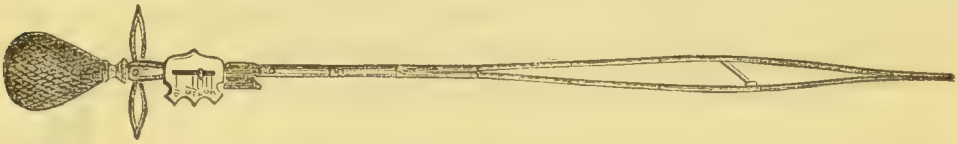


Fig. 954.—Thompson's Stricture-Expander.

c. The rupture or splitting of the stricture by an instrument acting on the principle of a **Wedge**, has been recommended by Reybard, adopted by Holt, and very extensively employed by the latter excellent Surgeon. The instrument used by him is represented in the accompanying figure (Fig. 955). It consists of two grooved metallic blades joined at the extremity. Between these a tube is slipped along a wire, which in its descent separates the blades at a considerable angle, and thus splits up the stricture. In this way the contracted part of the urethra is at once enlarged to its normal diameter, so as to admit a full-sized catheter, by which the urine is then drawn off. The introduction of the catheter should be had recourse to at first on alternate days, and afterwards at longer intervals. Holt believes that the effects of the dilatation are entirely confined to the morbid contraction, the healthy portion of the urethra not being injuriously disturbed by the expansion of the instrument.

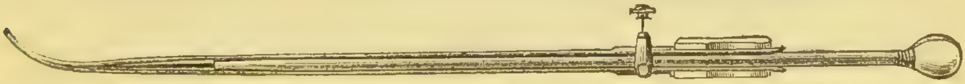


Fig. 955.—Holt's Instrument for Splitting Strictures.

Berkeley Hill has invented a modification of the dilators previously in use which presents several advantages. He thus describes it. "The instrument consists of a split sound, which equals in calibre a No. 2 or 3 catheter. The halves of the split sound can be separated by passing between them a wedge fixed on a slender stem. The wedge is prevented, by two dovetail grooves at its hinder part, from leaving the sound which acts as a guide during the passage of the wedge down the urethra." "The advantages claimed for this instrument are: simplicity of construction; the central guide of Holt's instrument is not needed, hence the split sound can be passed through narrower strictures. Next and chiefly, diminution of resistance, and consequently the more immediate application of the rupturing force—the wedge—to the impediment to be overcome. The force needed to push Holt's dilator is sometimes very great, and the attempt has been abandoned, or the instrument has broken, even in skilful hands, from this cause. Much of the force is expended on the continuous friction outside the tube along the split sound, and inside along the guide. In the wedge-dilator the friction-surface is reduced to two dovetail grooves, which together do not exceed half an inch. For this, the force required is so small that one hand suffices to overcome the resistance." The instrument can, if required, be adapted to a conducting sound, such as is described afterwards under Internal Urethrotomy.

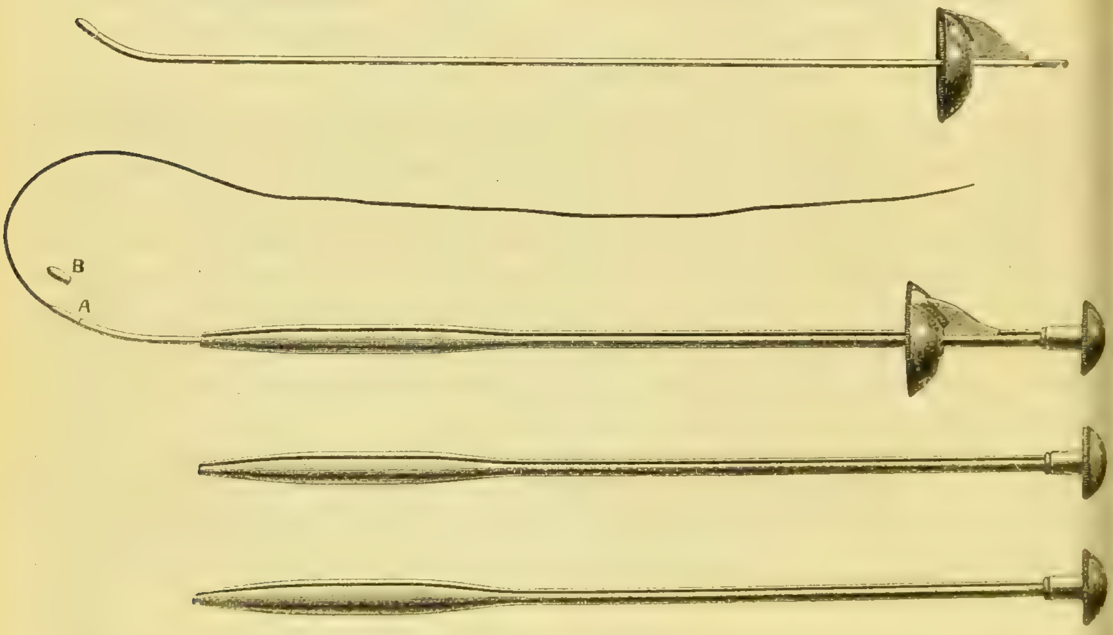


Fig. 956.—Bigelow's Divulsor.

Another instrument of the same class has been devised by Bigelow. It consists of a filiform conducting sound, which is first passed. The guiding rod is then screwed into this and passed into the bladder, pushing the conducting sound before it. The cup-shaped cap at the upper end of the guide rests on the glans, while the left hand grasps the body of the penis. The stricture is then dilated, forcing down the olive-shaped divulsor, which is deeply grooved to run on the guiding rod. Being olive-shaped it passes more easily, as in Hill's dilator, not being grasped by the whole canal.

Forcible dilatation is doubtless a most efficient mode of treating stricture; by it the urethra is immediately restored to its full diameter, and the result which it may take weeks to accomplish by simple dilatation is at once obtained. It is, however, by no means devoid of danger. The urethra is not dilated, it is split, and a longitudinal rent in the mucous membrane is made corresponding to the length of the stricture. The shock produced by so violent a proceeding is often severe, and suppression of urine has followed in several recorded cases. It has also been sometimes followed by urinary abscess, and more rarely by pyæmia. What it gains in rapidity it loses in safety, and to adopt it as a universal mode of treating strictures would lead to the loss of many lives that might have been saved by gentle treatment.

Division of the Stricture may be practised either from *within* the urethra, or from *without*, through the perinæum.

6. **Internal Urethrotomy.**—The division *from within* may be performed in two ways; either by cutting through the stricture from before backwards, or by passing a proper instrument through it, and dividing it from behind forwards.

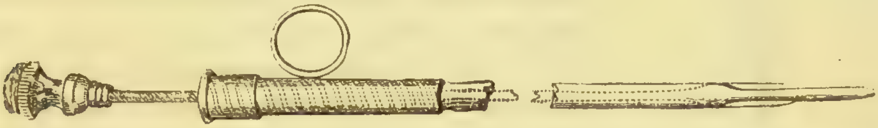


Fig. 957.—Lancetted Stylet for Division of Stricture.

The first operation—that of perforating the stricture *from before backwards*—may be performed by passing a lancetted stylet (Fig. 957) into the stricture, and then pushing forwards the concealed lancet-like knife, attempting to perforate the obstruction. This plan is necessarily attended by the most dangerous consequences, if an attempt be made to thrust a stylet through the stricture without a guide; the probability, indeed almost the certainty, being that the pointed cutting blade will pass by the stricture and divide the healthy wall of the urethra. It is, indeed, almost banished from surgical practice, and is applicable with safety only to those strictures that are situated in the part of the urethra anterior to the scrotum, where the canal is straight. In the deeper and more curved parts, any attempt at perforation would obviously be fraught with danger; for, as it would of course be impossible for the Surgeon to guide the stylet exactly in the direction of the urethra, it would be more likely to perforate the walls of this canal than to pass through the stricture. In hard and resisting contractions, however, in the straight portion of the canal anterior to the scrotum, such an instrument may occasionally be used with advantage. A very convenient form of cutting stylet is the one figured here, which has a probe end that is introduced through the stricture, and serves as a guide to the blade, which is projected and caused to retract into its cylinder by the action of a spring (Fig. 957).

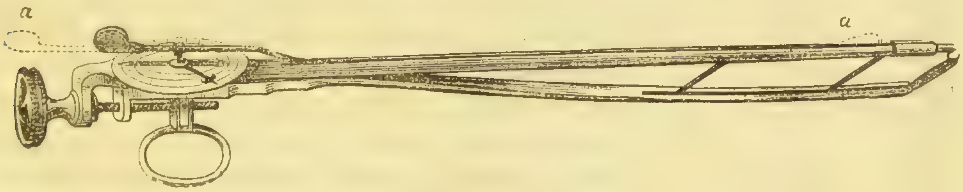


Fig. 958.—Dilator and Urethrometer.

During the last few years, great improvement has been made in the instruments employed in this operation, and it has consequently risen much in favour. Cutting from before backwards without a guide proved so dangerous, that it has been finally abandoned. On the other hand, the operation of cutting from behind forwards could not, until recently, be performed unless the stricture was capable of admitting a No. 5 at least. The Surgeons to whom we are most indebted for improvements in the instruments employed, are Van Buren, Gouley, and Otis of New York, Maisonneuve of Paris, and Berkeley Hill of London. The objects which these Surgeons have had in view have been, first, to provide a safe and certain guide for a small cutting instrument, and secondly, so far to diminish the size of the instruments as to make them available for strictures not capable of taking more than a No. 1 catheter. Lastly, as it was found that the great mobility of the urethra rendered it difficult in many cases to divide the stricture, a combination of stretching and cutting was introduced by Otis, which greatly facilitates the operation.

The guide to the bladder may be obtained in two ways. A fine whalebone bougie having been passed through the stricture, the urethrotome may be so constructed, by being tunnelled for a short distance at its point, as to slide over this into the bladder. But a better plan is the employment of Maisonneuve's *sonde conductrice*, or conducting sound. This is a very fine gum-elastic bougie, provided with a male screw at the end (Fig. 959 *a*). This is first passed on till it is supposed to be in the bladder. A small catheter corresponding to a No. 1, having a female screw at its extremity, is then screwed on to it and passed onwards, while the conducting sound coils up in the bladder. If the urine flow, it is then certain that the conducting sound has passed in the proper direction. It is now withdrawn again, the conducting sound being left in position. The catheter is now replaced by the urethrotome, which screws in the same way. Berkeley Hill has invented a very ingenious urethrotome for cutting from behind forwards, in which a very fine knife can be protruded from an instrument not larger than a No. 2. Another instrument invented by the same Surgeon for cutting from before

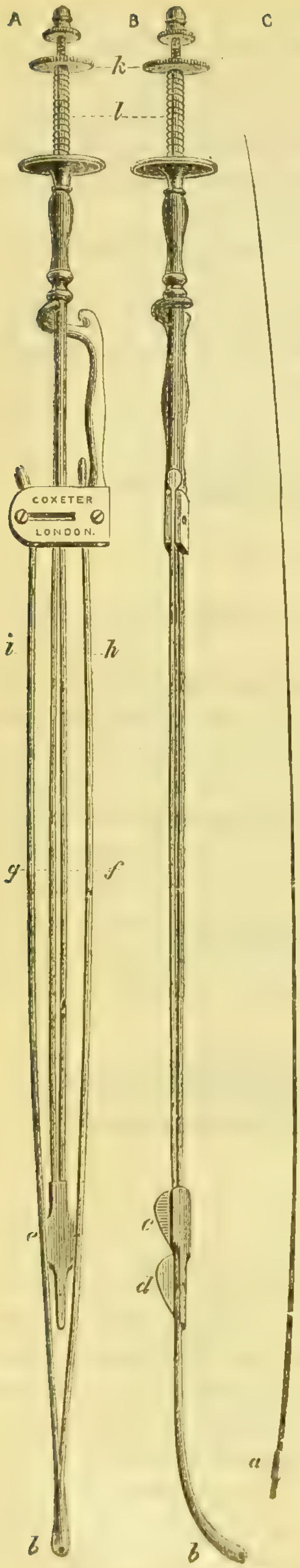


Fig. 959.—Berkeley Hill's Dilator and Urethrotome. A, Front View ; B, Side View ; C, Conducting Sound with small male screw at *a* ; *b*, female screw ; *c*, sheath for concealed knife ; *d*, knife protruded ; *e*, wedge for separating the blades *h* and *i* ; the knife is on the posterior aspect of the wedge ; *g*, rod for carrying the wedge ; *f*, rod for protruding the knife ; *k*, screw for regulating the distance to which the knife can be protruded ; *l*, spring to draw back the knife and keep it concealed, except when protruded by pressing the button opposite A and B. (In Fig. B. the button should have been represented as depressed.)

backwards is represented in Fig. 959. It combines the principles of several others, and has been found to work most successfully. It is thus employed. The conducting sound having been passed and ascertained to be in the bladder, the female screw *b* is applied to the male screw *a*, and the instrument passed through the stricture. The blades *i* and *h*, when closed, about equal a No. 3 catheter in size. The point *b* is about equal to a No. 1. The instrument having been passed, the wedge *e*, which contains a knife *d* concealed in a shield *c*, is now inserted between the blades and passed steadily down. The blades thus separated stretch and steady the urethra; and when the stricture is reached, the shield *c* stops against it and prevents further progress. The small concealed knife *d* is then protruded by pressing the button at the top of the instrument, and as soon as the finger is removed it is withdrawn again by the spring *l*. The wedge can then be passed on a little further, and if it hitch again the knife can be again protruded. By this means the urethra is cut only at the points of stricture, and no more wound is made than is absolutely necessary. The incision is always made downwards towards the floor of the urethra. This instrument may be employed in almost any stricture that will admit the conducting sound.

In slighter strictures Civiale's urethrotome (Fig. 960) may be used. In order to use this instrument, the stricture must be dilated up to about No. 5. The end of the instrument is then passed beyond it, and, the small blade having been made to project, the stricture is divided or notched downwards by firm and steady pressure to the extent usually of about an inch. The blade is then shut into its sheath, and the instrument is withdrawn. As this instrument does not steady the urethra, the penis must be pulled forward so as to put it on the stretch before the division is attempted, and this should be done by a steady pressure or a sawing motion rather than by a sudden effort.

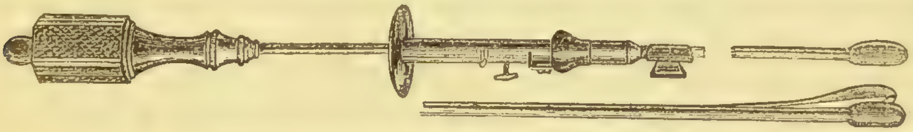


Fig. 960.—Civiale's Urethrotome.

After the operation of internal urethrotomy, a full-sized instrument should be immediately passed, but it is not usually necessary to tie it in. It should, however, be passed daily for a few days, and after that every second or third day for three or four weeks. After that, the patient should be taught to pass it for himself, and continue to do so occasionally for the rest of his life.

The operation of internal urethrotomy is, of course, required only in exceptional cases. These are chiefly resilient or very irritable, and some very tough strictures. In resilient strictures, dilatation fails because the stricture, though admitting of expansion, immediately relapses. In very irritable strictures, the patient cannot bear the pain of dilatation. In some very tough strictures, simple dilatation fails, and then internal urethrotomy or forcible dilatation is required. In all these cases, the division of the stricture from within removes at once all difficulty in treatment; and I have frequently employed this very simple method with the most marked and permanent success. In fact, in strictures of the scrotal or penile portions of the urethra, one or other of the above conditions—resiliency or irritability—commonly prevails, and I have generally found internal urethrotomy the best mode of treatment.

Result.—The risk attending the operation is not great, and diminishes as the stricture approaches the orifice of the urethra. It is not, however, free from danger. The accidents that may happen are, perinæal abscess, extravasation of urine, hæmorrhage, and orchitis ; and in some rare cases it may be followed by pyæmia. If the kidneys be diseased, it may, like any other operation for stricture, give rise to fatal acute interstitial nephritis. Perinæal abscess usually results from cutting too deeply, so that the knife completely divides the corpus spongiosum. Such abscesses most frequently form beneath the accelerator urinæ, and burrow forwards, directed by the expansion of that muscle to the root of the penis. They contain a mixture of urine and pus, but it is rare to find general extravasation into the scrotum. Hæmorrhage also results from cutting too freely. In rare cases, after the operation, a permanently bent condition of the penis remains during erection. We possess as yet but few trustworthy statistics of the results of internal urethrotomy, and there is every reason to believe that untoward consequences follow this operation more frequently than some of its advocates are willing to admit. Statistics of this operation done in private are worthless ; those of cases occurring in Hospital practice scarcely exist. In University College Hospital, where the operation has been extensively practised, I find from the Reports of the Surgical Registrar that the results are as follows. In 76 cases operated on during a period of five years, there were 4 deaths, one from tubercular disease of kidneys, lungs, &c., one from pleurisy, one from septicæmia, and one from suppurative nephritis. Perinæal abscess occurred in 8 cases ; extravasation of urine in 1, and epididymitis in 4. There was hæmorrhage in 5, and in 2 the patient was left with permanent chordee during erection.

(For the effects produced on the kidneys by splitting strictures and internal urethrotomy, see Chap. LXVI.)

7. **External Urethrotomy.**—The division of the stricture *from without*, by incision through the perinæum, may be performed by two distinct operations ; the one being applicable only to those strictures that are pervious to an instrument ; the other to those which are impermeable. In the first case a grooved staff is passed through the stricture, and the section is made upon this. In the second case, the Surgeon cuts through the stricture, without any guidance except such as his anatomical knowledge may afford.

Operation for Permeable Stricture.—The first of these operations, introduced by Syme as *Urethrotomy*, and commonly called the *Perinæal Section*, is comparatively a simple procedure. The instruments required for its performance are a staff, a No. 8 silver catheter, a pointed scalpel, and a broad director. The staff should vary in size from No. 1 to No. 6, according to the tightness of the stricture ; it should be grooved along its convexity, either the whole of the way, or better, merely for the lower third (Fig. 961). The stem is smooth and of full size, and joins into the lower grooved part by a distinct shoulder, which, being passed down as far as the stricture, forms by its projection a guide to the part of the urethra requiring division. In those cases in which there are false passages, a hollow staff of the same size and shape may be advantageously used ; the flow of urine through it indicating with certainty its passage into the posterior part of the urethra.

Performance of Perinæal Section.—The operation is performed as follows. The staff having been passed well through the stricture, so that the shoulder rests against the upper part of the constriction, the patient is tied up as for lithotomy, and the Surgeon, seating himself in front, pushes the scalpel, with the back of the blade downwards, into the mesial line of the perinæum a little above the rectum, and cuts upwards for an inch or more into the raphé. The dissection is carried on very carefully exactly in the median line until the staff is reached, when the knife must be entered into its groove *behind* the stricture, and carried forwards through this. The staff, having been pushed on to ascertain that all is free, must be withdrawn, and a No. 8 catheter introduced, which is to be kept in for forty-eight hours; it must then be taken out, and at the end of eight or ten days the urethra must be dilated by the introduction every second day of a full-sized silver catheter. Urine escapes for some little time by the perinæal incision; but, as this heals by granulation, the flow of fluid gradually lessens and at last ceases entirely.

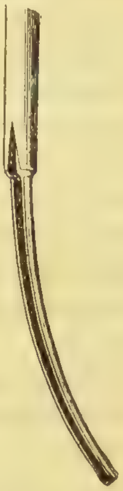


Fig. 961. Shouldered Staff for Perinæal Section.

The principal points to be attended to in this operation are—

1. To see that the staff is fairly through the stricture, and to be especially careful in determining this if false passages exist.

2. To cut carefully in the median line; where, as Syme has observed, a kind of septum exists even in the deeper structures of the perinæum, and where there can be no danger whatever of dividing any artery of magnitude, which might happen if any lateral deviation of the knife took place. The only vessel, indeed, which is at all endangered, is the artery of the bulb; and this will of course be avoided by carefully keeping in the raphé.

3. To enter the point of the knife behind the stricture, and to divide that by cutting forwards in the groove of the staff.

4. Much difficulty has occasionally arisen in the introduction of the catheter into the bladder after the division of the stricture. This may be avoided by passing a broad director, with the groove turned up, into the posterior part of the urethra after the stricture has been cut, but before the staff is withdrawn. As the catheter is passed down the canal, its point will infallibly be guided by this onwards into the bladder.

Where there are more strictures than one, the division of the deepest is usually alone necessary; the others may be dilated.

Result.—The result of the perinæal section, so far as the life of the patient is concerned, is usually satisfactory; yet cases have not unfrequently occurred in which a fatal termination has been the consequence, and there is every reason to believe that such cases have been more numerous than the advocates of this operation have been willing to admit. Occasionally, an incurable fistulous opening has been left in the perinæum; and not unfrequently accidents of a grave though not fatal character, such as inflammatory œdema of the scrotum, abscess in perinæo, &c., have been found to supervene.

The whole value of urethrotomy will at last depend on the liability of the stricture to return after its division; and this point has not as yet been by any means satisfactorily determined. The operation is now rarely practised, being reserved for cases complicated by urinary fistula or perinæal abscess. Its place has been taken by internal urethrotomy in all ordinary cases. Its advocates formerly maintained that it was a permanent cure, but as in all other operations for stricture, the ultimate result depends upon keeping up dilatation of the urethra for some months after the division of the stricture, a catheter of full size being passed once in a week or ten days. If this precaution be neglected, relapse will certainly occur. Against external urethrotomy it has been argued that, like a wound, the incision into the urethra might occasion a cicatrix which would contract, and thus eventually tend still further to lessen the diameter of the canal. But *post-mortem* examination of patients who have died some years after this operation had been performed has shown that the idea is groundless, the cicatrix being linear and scarcely perceptible. In fact, there is a great difference in the result, between cases in which the urethra has been divided transversely and those in which it has been incised longitudinally. In the first instance, a dense and contractile cicatricial mass is formed ; in the second case, a linear and scarcely perceptible scar.

Subcutaneous Urethrotomy is a modification of the preceding operation. It consists in dividing the stricture on a grooved staff by means of a fine narrow-bladed tenotome. After this has been done a full-sized catheter is tied in for from twenty-four to forty-eight hours. It is adapted only to ring-shaped strictures implicating the submucous tissue and mucous membrane only, without any extensive chronic inflammatory induration of the surrounding parts. These are, however, specially suited to internal urethrotomy over which the subcutaneous operation seems to possess no advantages.

Comparison of Methods of Treatment.—Gradual dilatation, carried on with patience and gentleness,—if need be, on account of the irritability of the urethra or the sensitiveness of the patient, with the help of anæsthetics,—will suffice for the cure of the vast majority of strictures ; and it rarely becomes necessary for a Surgeon who combines patience with skill to have recourse to those more severe methods of treatment which have been somewhat unduly extolled and too often unnecessarily practised. The urethra is indeed frequently treated as if it were an inert tube, to which the various practices of rupture, splitting, forcible dilatation, or incision, could be applied with impunity, rather than a highly sensitive canal, very apt to resent, locally or constitutionally, undue violence applied to it.

But, whilst we fully recognize this important point, and hold with Liston that whenever a catheter can be got through a stricture its cure by dilatation is all but certain in the hands of a skilful Surgeon, yet it is undoubtedly the fact that cases do occasionally occur in which simple dilatation fails to effect a cure ; the stricture being highly contractile, and not allowing expansion beyond a certain point, or relapsing whenever the dilating means are removed. In other cases, also, the patient suffers so much pain and irritation whenever an instrument is passed, that he cannot bear the repeated introductions that are necessary, more particularly if the stricture be complicated with fistulæ in perinæo or false passages, which render its cure by dilatation tedious and almost impracticable. In such cases as these the Surgeon, being unable to benefit his patient materially by dilatation, must choose between the employment of palliative means or more active measures.

It appears to me that there are four classes of cases, in which more energetic means than simple dilatation may not only be advantageously employed, but are absolutely required.

1. *Very old dense cartilaginous strictures*, often of traumatic origin, which admit an instrument with great difficulty, and cannot be dilated beyond a certain point, owing to the conversion of the urethral structures into a kind of dense, fibrous, almost cicatricial tissue, which neither admits of expansion nor of absorption by the pressure of instruments ; and in which a considerable extent—half an inch or more—of the urethra is involved.

2. The same kind of stricture, complicated with *fistulæ* in the perinæum or scrotum, with perhaps considerable plastic infiltration of these parts. In both these classes, I think that the perinæal section or external urethrotomy is to be preferred, though with the improved instruments of the present day some of the first class may be successfully treated by internal urethrotomy.

3. Very *tight strictures*, accompanied by *excessive sensitiveness* of the urethra ; in which each introduction of the instrument is attended by intense suffering and rigors, so that the patient cannot be induced to submit to a proper course of bougies.

4. Very *elastic*, though perhaps *narrow strictures*, that can be dilated readily enough, even up to the admission of full-sized instruments ; but which, when the treatment is discontinued, immediately begin to contract again, so that the patient is never out of the Surgeon's hands, and sees no prospect of cure.

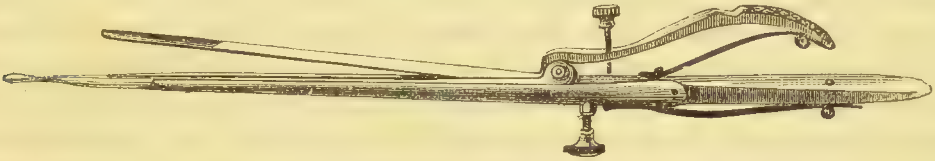


Fig. 962.—Civiale's Urethrotome for Stricture of the Orifice, modified.

In these last two classes of cases, I am of opinion that internal urethrotomy, or the forcible expansion or rupture of the stricture, is the best method of treatment ; the perinæal section being too severe and dangerous, whilst simple dilatation is too feeble a means of treatment.

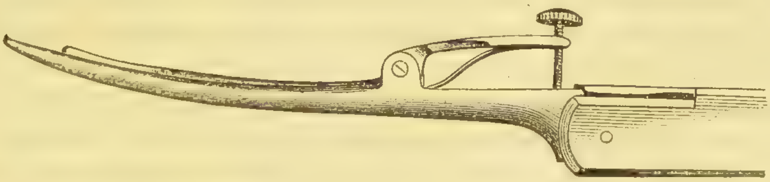


Fig. 963.—Another form of Bistouri Caché.

Stricture of the Urethral Orifice is usually the consequence of destruction of tissue by a chancre. It is apt to be extremely tight, and has a great tendency to relapse. A tight stricture is not uncommonly met with also within an inch of the orifice as the consequence of an intra-urethral chancre, and less commonly of gonorrhœa.

These strictures may be treated by *gradual dilatation* by means of short nail-headed styles of graduated sizes, but this is usually tedious and inefficient. *Division* by Civiale's instrument, introduced shut, and cutting as it is withdrawn (Fig. 962), or in the absence of this, by a common probe-pointed bistoury, will be found the only really advantageous treatment. It is practically free from danger, as rigors and other constitutional disturbance, scarcely ever follow operations on the anterior extremity of the urethra.

Impermeable Stricture.—In order to perform the perinæal section, the stricture must be pervious to a grooved staff, however small this may be ; and this, it might be supposed, would limit materially the cases in which the operation can be performed. But complete obliteration of the urethra cannot take place except as the result of sloughing, usually from injury ; indeed "impermeable" strictures, though frequently spoken of, are very rarely met with. Syme, indeed, denied their existence, and stated that, if urine can escape through a stricture, a bougie can be introduced. A Surgeon may often be foiled in his first attempts to pass an instrument through a very tight stricture. But I believe that, with patience, by attention to constitutional treatment, so as to lessen urethral irritation, and especially by the administration of chloroform, he will usually at last succeed in making an instrument of some kind pass through the very worst strictures. In the first case in which I performed the perinæal section, almost all the urine had for twelve years been discharged through fistulous openings in the perinæum and scrotum ; and the principal portion escaped through a large hole on the inside of the left thigh, only a few drops occasionally passing out by the lips of the urethra. No instrument had been passed for four years, though repeated attempts had been made by different Surgeons. Being foiled in introducing a catheter into the bladder the first time I tried, I kept the patient in the Hospital for two or three weeks, attending carefully to his constitutional condition, but without making any further effort. He was then placed under chloroform, when I succeeded in passing No. 1. The urethra was then dilated up to No. 5, beyond which no instrument could be passed, when the perinæal section was performed. The patient made an excellent recovery, the fistulous openings closing, and the urine being discharged by the natural channel. In another case, persevering attempts had been made for five years to make an instrument enter the bladder, but without success, the stricture not only being excessively tight, but the urethra acutely sensitive ; under chloroform I succeeded in introducing No. ½ silver catheter into the bladder, and speedily cured the patient.

The influence of *Anæsthetics* in facilitating the passage of instruments through apparently impermeable strictures is very marked. Shortly after the introduction of ether as an anæsthetic agent, Liston was going to cut through a stricture that had resisted all attempts made by his most dexterous hand at introducing an instrument into the bladder ; but no sooner was the patient put on the table and rendered insensible, than the No. 8 silver catheter, which had been passed down as far as the stricture, and the point of which was to serve as a guide to the knife, slipped into the bladder, and thus rendered a dangerous operation unnecessary.

Yet no Surgeon can doubt that cases do occasionally, though rarely, occur, in which, in consequence of extravasation of urine and old inflammatory mischief, the urethra has become so tortuous and narrow, and the perinæum so thickened and indurated, that an instrument cannot be passed through, even though the urine pass out readily. It must be borne in mind that a stricture may be permeable to urine, but impermeable to a catheter, even in the most dexterous hands. It does not follow necessarily that, because a fluid will trickle out of a narrow and tortuous channel, a catheter or solid sound can be passed into it from without. In a case of extravasation of urine following stricture, consequent on injury of the perinæum, sent to me by Corrie of Finchley, in which no catheter had been introduced for eight years, it was found after death that, although the urethra had been converted into a mass of cicatricial tissue at the part injured, it was yet permeated by a narrow tortuous passage, through which the urine had escaped.

Hence cases will occasionally occur, in which the perinæal section is not practicable. In the event, therefore, of a stricture being so tight and tortuous that no instrument will pass through it, or where, a portion of the urethra having sloughed away, its canal is obliterated, neither the cure by dilatation nor urethrotomy can be performed, and it may then be necessary to have recourse to incision of the stricture without a guide.

Operations for Impermeable Stricture.—In operating for the relief of impermeable stricture various means have been adopted, the chief of which are, 1, opening the urethra behind the stricture ; 2, opening the urethra behind the stricture and cutting forwards through the constriction ; 3, opening the urethra in front and dividing the stricture from before backwards.

1. **Opening the Urethra behind the Stricture,** or as it is often called in this country "Cock's operation," is thus performed. The patient having been prepared as for lithotomy, the operator introduces his left forefinger into the rectum. He then takes a broad sharp-pointed knife, which Cock advised should be double-edged, and passes it towards the apex of the prostate, guiding its course by the finger in the rectum. The knife must be passed at one thrust to the apex of the prostate, and great care must be taken that it keeps accurately to the middle line. The external wound is then enlarged somewhat by moving the knife up and down, till the lower angle reaches to about half an inch from the anus. The knife is then withdrawn and a large probe-pointed director with a handle is passed through the prostatic urethra from the wound, and along this a female catheter, or an instrument of that shape fitted with rings by which it can be securely tied in, is guided into the bladder. The essential points of the operation are to keep accurately to the middle line and to open the urethra as it emerges from the prostate gland. Should the prostate itself be notched no harm will result. The instrument having been passed as above described is tied in and retained for some days or weeks as may be required. In a very large proportion of cases after the irritation of the passage of urine through the narrow stricture has been removed, a certain degree of relaxation will take place, and a few days after the operation it frequently happens that a catheter will pass through the stricture which was formerly "impermeable." If this does not take place, an effort may subsequently be made by some further operative procedure to open up a way in the natural line of the urethra, and should this fail the patient may pass his urine permanently through the fistulous opening in the perinæum. This can be kept readily open by the occasional passage of a flexible bougie, which must be left *in situ* for a few hours. Cock records cases in which the patient passed his water in this way for twenty years or more. The opening being well in front of the prostate the control over the escape of urine is perfect, and the patient's mode of micturition is assimilated to that of the other sex.

This operation is best adapted to those cases in which the patient is suffering from actual retention at the time the Surgeon is called upon to operate. The objection to it is that it does nothing to relieve the stricture unless this should happen to yield after the irritation of the passage of urine is cut off.

2. **Opening the Urethra behind the Stricture and cutting forwards.**—This operation may be regarded as an extension of the preceding method. It is thus performed. A No. 8 silver catheter is passed down to the stricture; the patient is then tied up as if for lithotomy; and the Surgeon, sitting in front, pushes a bistoury with the back turned towards the rectum into the raphé of the perinæum as far as the apex of the prostate, so as, if possible, to open the dilated urethra *behind* the stricture. He then cuts *forwards* through the stricture on to the point of the catheter, and, having thus opened a passage, endeavours to pass that instrument on into the bladder. This operation, I have no hesitation in saying, is one of the most troublesome in surgery. I have more than once seen the most skilful operators foiled in their endeavours to accomplish it, and compelled to relinquish the operation without concluding it or succeeding only after prolonged and most painful attempts. The difficulty consists in finding the posterior part of the urethra. When the tissues of the perinæum are hard and gristly from repeated attacks of inflammation and the presence of fistulæ, it is a most difficult matter to dissect through such an altered mass and hit the urethra beyond it, and the difficulty is still further increased by the bleeding which is often very profuse. Moreover, should the Surgeon find the posterior part of the urethra and cut forwards from it to the catheter in the urethra, the chances are that his incision will not follow the line of the urethra, and the fistulous track he establishes between the part of the urethra in front of the stricture and that behind it will almost to a certainty contract as the wound heals to such an extent as to leave the patient little better for the operation.

3. **Opening the Urethra in Front of the Stricture and dividing from behind backwards.**—This operation, though difficult of performance in some cases, gives better results than any other. Wheelhouse has invented some ingenious instruments which greatly facilitate its performance.

The operation is thus performed. The patient having been secured in the lithotomy position, Wheelhouse's staff is passed down to the stricture. The end of this is about the size of a No. 8 catheter; on one side it is flattened and grooved, and on the other it forms a small blunt hook, with which the upper end of the "button-hole" incision in the urethra may be drawn upwards. The staff being passed and held with the grooved side forwards, the Surgeon cuts down upon it by an incision about 1½ in. long in the median line and opens the urethra just above the stricture. The staff is now pushed out at the wound and turned round, so that the small hook is forwards: it is then drawn upwards so as to catch in the upper angle of the opening, and in this way the urethra is put on the stretch and steadied. If the special staff be not at hand, the end of a catheter can be cut down on with almost equal ease. The edges of the slit in the urethra are then seized in artery-forceps and held apart so as to expose the interior of the canal which can be readily recognized by its smooth shining surface. It will often be found to be convenient to pass a silk suture through each side by which the edges may be held apart, as the forceps are rather apt to get in the way. Oozing having been allowed to cease, the aperture leading to the stricture will usually be found without very great difficulty. The chief trouble in many cases arises from the constant trickling of blood from the upper part of the wound. This may be arrested by plugging it with a small sponge, or by the application of water, at a temperature of about 140° F., which is usually more efficient than ice. Another difficulty may arise from the urethra having been opened too far above the stricture, under which circumstances the incision must be prolonged downwards. If a false passage have been opened instead of the urethra it is recognized by the absence of the smooth pink mucous membrane. The orifice of the stricture must be sought for with a fine probe. Wheelhouse uses a small probe-pointed director. In some cases the small director used in slitting up the canaliculus will be found to pass when other instruments have failed. In seeking the true orifice of the stricture every depression must be carefully explored without force. Pressure above the pubes will often cause a slight escape of urine by which the proper orifice may be recognized. When the opening is found and the probe passed, the stricture must be divided along it with a fine knife or tenotome. Wheelhouse then passes a small gorget through the stricture, and along this a full-sized catheter can be easily guided into the bladder. It must be tied in and retained for a few days. The wound may be wiped out with a strong solution of chloride of zinc and afterwards sprinkled with iodoform and filled with iodoform-wool, which may be left undisturbed till the third day, when healthy granulation will usually be found to have commenced. This operation requires care and patience, but it is easier and safer than any other.

General Results of the Treatment of Stricture.—Whether it is or is not possible permanently to cure a stricture, is a question which has been much debated. The advocates of the various modes of treatment, whether forcible dilatation, internal urethrotomy, external urethrotomy, electrolysis, or caustics, have often asserted that by the means they adopt a stricture can be really cured, so that the patient is rid of his disease for ever, and need fear no return. The general opinion, however, of those who have studied this question carefully, is that although a patient can be put into a position in which his stricture need never be a source of danger to him if he occasionally passes an instrument, he cannot be really cured—that is to say, by no means of treatment can a strictured urethra be restored to its normal condition. Every patient, therefore, who has once suffered from a definite organic stricture, should continue for the rest of his life to pass a full-sized instrument not less than once a month; otherwise, gradual contraction is almost certain to take place, and the whole treatment will have to be commenced again.

COMPLICATIONS AND RESULTS OF STRICTURE.

Retention of Urine has already been several times described as arising from different causes. Thus, in boys, it arises from the impaction of a calculus in the urethra; in girls it is usually hysterical; in old men it is almost invariably the consequence of atony of the bladder or enlarged prostate, alone or combined. In those of middle age, stricture of the urethra is the occasioning cause in the vast majority of cases. Retention of urine has a tendency to occur in all tight strictures from the gradual and progressive contraction of the canal. It most usually, however, takes place in consequence of a congestive spasmodic condition being superadded to the organic constriction. It commonly happens that a patient having a moderately tight organic stricture commits an excess, or becomes exposed to cold and wet, and thus gets such a congested condition superadded, that the urine will not pass at all, or only in such small quantity by drops, and with so much pain and straining, that the bladder cannot be completely emptied. In these cases the retention always eventually becomes complete ; the bladder speedily fills, and rises above the pubes ; there is much distress and constitutional disturbance ; and, if relief be not afforded, the distended portion of the urethra behind the stricture will ultimately give way, and extravasation of urine ensue. In these circumstances it becomes imperatively necessary to empty the patient's bladder as speedily as possible.

Treatment.—This varies with the severity of the symptoms and irritability of the patient. If the retention have not continued very long, and if the patient be not very irritable, an endeavour might be made at once to give relief by passing a small catheter into the bladder. In this the Surgeon may often succeed more readily than might have been expected, the stricture frequently yielding before an instrument more easily when there is retention than when this condition does not exist. Even if the catheter do not enter the bladder, its point or that of a catgut bougie merely being introduced well into the stricture, it will generally happen, as Brodie has pointed out, that, on the withdrawal of the instrument, the urine will follow in a full stream ; but if a sufficiently small catheter be used (in many cases not larger than half of No. 1 is admissible), the instrument may usually be made fairly to enter the bladder. If the patient be very irritable it is better, before attempting the introduction of the instrument, to give him an opiate enema of a drachm of laudanum in about two ounces of starch, and to put him in a warm hip-bath, when perhaps he may pass water, but if he does not the introduction of the catheter may be attempted, and will generally succeed. Should it still fail, the effect of an anæsthetic should be tried, when it almost invariably may be made to pass without the employment of any great or dangerous degree of force. There are no cases in surgery in which anæsthesia is of more value than in these ; under its influence it is seldom, indeed, that the catheter will not pass. If a very small catheter only can be introduced, it often happens that the eye is blocked by a clot of blood, and the Surgeon may think he has not entered the bladder. This difficulty is overcome by applying an aspirator to the catheter, which will immediately clean it if it be really in the bladder. It is wiser, therefore, always to have that instrument at hand when attempting to relieve a case of retention of urine. After the catheter has been passed into the bladder it should be left there, being tied in by means of tapes passing from its rings under the patient's thighs, to a bandage that is passed round his waist. A free purge may be administered on the following day, and the patient should be confined to bed. The catheter will be found to be loosened at the end of forty-eight hours, when it should be withdrawn, and the cure by dilatation proceeded with in the usual way.

There are two conditions which in retention of urine may eventually call for operative interference. The first is the necessity for very frequent introduction of the catheter, owing to an irritable state of the bladder. In these cases, it may eventually be thought safer to puncture the bladder and to establish a direct opening, either through the rectum or above the pubes, rather than subject the patient to the constant terror of repeated catheterism, which will end by exhausting him. Every act of catheterism inflicts a certain shock to the system, greater in some, less in others ; and if this have to be repeated every three or four hours, less danger will probably result from puncture of the bladder than from the frequent use of the instrument. In these cases the patient cannot allow it to be tied in for the same reason, that of extreme irritability, which necessitates its repeated introduction.

The second condition that calls for operation is a different one, viz., the necessity of relieving retention of urine. For if the Surgeon be unable to introduce a catheter in the ordinary way through the stricture, relief must be given to the over-distended bladder in some other way, lest it or the urethra burst, and extravasation of urine occur. The bladder may be emptied in five ways: 1, by Forcible Catheterism; 2, by making an Opening into the Urethra behind and through the Stricture; 3, by Puncturing the bladder through the Rectum; and 4, by Puncturing it above the Pubes, and 5, by Aspiration.

1. **Forcible Catheterism** is a most unsurgical and dangerous procedure. Nothing can surely be more improper than to take a small, stiff, silver catheter, pass it down to the stricture, and then, by main force, attempt to drive it on into the bladder. In these cases the Surgeon usually fails in his attempt to reach the viscus, but pushes the point of the instrument into the tissues around the neck of the bladder or into the prostate, and thus induces great, and perhaps even fatal, mischief in these regions. If he should, by some fortunate accident, reach the bladder, it is not by any skilful though forcible expansion of the stricture, but rather by perforating the urethra, and burrowing through the corpus spongiosum and prostate—"tunnelling," as it has been termed—until he again enter that canal, or in some such way reach the neck of the bladder.

2. **Opening the Urethra behind and through the Stricture.**—In the kind of retention of urine that we are now discussing, the safest, though by no means the easiest mode of affording relief after the failure of the catheter, is to make an incision into the middle line of the perinæum, and to open the urethra behind or through the stricture. In many cases the simple opening of the distended sinus beyond the stricture will be found the most convenient mode of treatment, especially if the operation has to be done in a hurry and without all the conveniences which surround the Surgeon in hospital practice. If, however, it is practicable, it is better to perform the operation from before the stricture, and thus to relieve the disease at the same time as the retention. Simple puncture of the dilated pouch behind the stricture is, as has been already pointed out, easier in cases of retention, as it is usually tensely distended and may attain a considerable magnitude. The mode of performing these operations has already been sufficiently described, pp. 1167–1169.

Another advantage of the perinæal incision in these cases is, that it not unfrequently happens that urinary abscess has begun to form, or the extravasation of a few drops of urine has taken place sooner than the Surgeon may have had any idea of: and if so, the incision through the perinæum will afford an exit for any extravasated matters, at the same time that it relieves the patient from the distress and danger of the retention. Should any mischief of this kind have taken place, it is not necessary to be so particular about opening the urethra with the knife; for, an aperture having already been established in it, the urine will readily flow through the artificial channel thus formed by free incision into the inflamed or suppurating perinæum.

3. **Puncture of the Bladder through the Rectum.**—After emptying

the bowel by means of an enema, the Surgeon passes the left index-finger well into the gut, feeling for the posterior margin of the prostate ; he then carries the trochar and cannula, which are long and somewhat curved, upon this as a guide, and, when the extremity of the instrument has reached the posterior edge of the prostate, he pushes it upwards into the bladder (Fig. 942). The seat of the puncture between but in front of the ureters is well shown in Fig. 964, which represents the bladder and strictured urethra of a man who died some days after this operation had been performed for retention from stricture. In performing this operation, the Surgeon perforates the bladder in that portion of its fundus which is uncovered by peritoneum, being bounded behind by the reflection of the serous membrane, anteriorly by the prostate, and on each side by the vesiculæ seminales. In order to avoid wounding any of these structures, he should keep strictly in the mesial line, and puncture immediately behind the prostate. In introducing the instrument into the rectum, the Surgeon should withdraw the point of the trochar into the cannula, so as to avoid wounding the gut, and not push it forwards until he has the end of the cannula fixed against the spot where he intends to make the perforation. In making the puncture the instrument must be directed forwards towards the umbilicus. After withdrawing the stylet and emptying the bladder, the cannula should be tied in by means of tapes. It is often difficult to prevent the cannula from slipping out of the wound when only tied in, and thus exposing the patient to the danger of urinary infiltration. It may be securely retained by means of a stitch of silver wire passed on either side through the slit in the guard and the contiguous skin of the nates. The cannula should be retained for a few days until urine begins to pass by the urethra, or until a catheter has been passed through the stricture, when it must be withdrawn and the aperture left to close. The irritation of the passage of the urine having been removed from the urethra, a catheter may often be passed a few days after the operation ; and the stricture will readily yield to dilatation in the ordinary way.

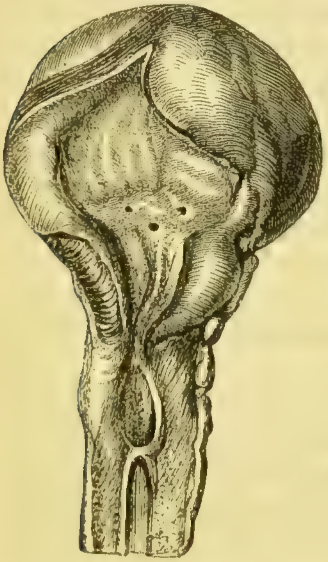


Fig. 964.—Seat of Puncture through Rectum in a case of Stricture.

This operation has the advantage of being far easier of performance than the last, and may doubtless occasionally be required in those very rare cases of retention from stricture in which there is no sign of abscess or extravasation in the perinæum, in which the urethra appears not to be dilated behind the stricture, in which the prostate is not enlarged, and in which under chloroform, and with patience, a catheter cannot be passed into the bladder ; a combination of circumstances that will but very rarely indeed occur to a Surgeon skilled in the use of his instruments.

The operation of puncture through the rectum is not devoid of danger ; peritonitis, urinary infiltration, and pelvic inflammation and abscess, may result from it. The recto-vesical pouch of the peritoneum will sometimes descend so abnormally low as to cover the *bas fond* of the bladder as far as the prostate, leaving no space for a puncture to be safely made. This condition necessarily cannot be determined during life, hence its great danger. I have known two instances in which a double puncture was in this way made through the fold of the recto-vesical pouch, half an inch beyond an unenlarged prostate, for relief of retention. In both cases, death from peritonitis occurred. The preparations are in University College Museum.

In a remarkable case that was under my care at the Hospital (in 1859), a sequence occurred which I have never seen noticed: viz., the diffusion of rectal flatus through the areolar tissue of the pelvis and down the thighs and nates, producing an emphysematous condition of these parts and the death of the patient. The case was briefly as follows. A middle-aged man had suffered from traumatic stricture for very many years—indeed, from childhood. He was admitted with retention. As no catheter ever had been or could be passed, I punctured the bladder by the rectum in the usual way. The cannula was removed on the fifth day. He then passed urine *per urethram*, and continued to do so up to the time of his death. The day after the withdrawal of the cannula he felt very ill, but without any positive or tangible complaint. The next day it was found that the back and inner part of both thighs were emphysematous and crackling, evidently distended with gas. The emphysema extended downwards and also up the flanks, and appeared even in the right arm. There was no pain or discoloration. He died on the following day, the eighth after the puncture. After death no trace of pelvic inflammation, suppuration, or urinary extravasation was found; but there was much infiltration of gas under the pelvic peritoneum, and in the areolar tissue between the bladder and rectum. The gas had probably passed through the sciatic notches into the posterior parts of the thighs. It was fetid, like intestinal flatus.

4. **Puncture of the Bladder above the Pubes**, in cases of retention from stricture, is but seldom resorted to; although some Surgeons of eminence have strongly recommended and often practised it. This operation, which has been discussed at p. 1119, is undoubtedly easy of performance, and sufficiently safe, though not free from the danger of infiltration of urine into the tissues around the puncture, and of the inconvenience of a fistulous opening being left. There is one class of cases to which it appears to be especially applicable, and in which I have had occasion to practise it; viz., those cases of retention from impassable stricture, in which there co-exists an enlargement of the prostate, rendering puncture through the rectum impossible, the Surgeon's finger not being able to reach beyond the enlarged gland; and here undoubtedly the safest, if not the only course to pursue, is the suprapubic puncture. In some cases of impermeable stricture, Paget, of Leicester, has established a permanent fistulous opening above the pubes, the patient wearing a tube, through which he passed his water. Sir Henry Thompson also has adopted a similar proceeding in disease of the bladder with painful and frequent micturition, in which catheterism could not be carried out.

Brainard has suggested that, after tapping above the pubes, especially if the cause of difficulty in passing an instrument has been in great part the presence of false passages, an attempt may be made to pass instruments from the bladder down the urethra.

5. **The Employment of the Aspirator** for the purpose of emptying an over-distended bladder is, however, upon the whole the simplest method of treatment, and should be preferred to any of the preceding plans, in the first

instance at all events. The perforating trochar of the aspirator should be passed directly into the bladder above the pubes. The operation is a simple one, and with a little care is perfectly safe. The chief points are not to thrust the needle too deeply, to direct it well behind the pubes, and gently to withdraw it before the whole of the urine has escaped, so as to prevent the emptied bladder from collapsing upon and being wounded by its point (see p. 732, Vol. II.).

After the bladder has been punctured, either through the rectum or above the pubes, means must be taken to restore the calibre of the urethra, so as to prevent the orifice of the puncture from degenerating into a permanent fistulous opening. With this view the cannula should be left in the bladder, and the urine allowed to discharge through it for from four to six days. At the expiration of this time, should no urine have passed by the urethra, the stricture in the canal will be found to be relaxed, and a small instrument may usually without much difficulty be introduced into the bladder, where it should be retained, the cannula being withdrawn. The cure of the stricture may then be proceeded with in the usual way.

Extravasation of Urine is one of the most dangerous and fatal results of unrelieved retention. This accident may occur in consequence of rupture of the dilated portion of the urethra which is immediately behind the stricture. It then takes place suddenly, the patient, while suffering from retention, feeling something give way during a violent effort at micturition, and at the same time there is a sense of some relief, as if he were emptying the bladder, followed by a hot and burning throbbing pain in the perinæum.

In other cases the process is more gradual, and is preceded by the formation of an abscess in the immediate neighbourhood of the urethra, most probably commencing in one of the lacunæ or glands opening into it. The abscess bursts into the urethra, and its cavity is subsequently distended with urine at each act of micturition ; finally its walls give way, and general extravasation takes place. In some cases it is probable that the abscess arises from a very limited extravasation of urine into the tissues in the immediate neighbourhood of the urethra, consequent upon ulceration of the mucous membrane behind the stricture. In these cases the signs of perinæal abscess, to be presently described, precede the extravasation often for some days.

The part of the urethra that gives way is almost invariably the membranous portion of the canal, just between the layers of the triangular ligament, where it is weak, being least supported by surrounding structures, and usually most dilated and attenuated by the pressure to which it has been subjected. The extravasated urine afterwards finds its way through the anterior layer of the triangular ligament, where it is perforated by the urethra, and so beneath the deep layer of the superficial fascia of the perinæum, by which its course is afterwards directed. This fascia is firmly attached across the perinæum to the free border of the triangular ligament and, along each side, to the rami of the ischium and pubes, as far upwards as the pubic spine, from which point its attachments are continued outwards along Poupart's ligament to the crest of the ilium. The extravasated urine, therefore, uniformly takes a course forward into the perinæum and scrotum, and upwards upon the external organs of generation, the groins, and the anterior abdominal wall ; so that it ascends contrary to gravity rather than soaks back into the more dependent parts of the body, as it would do were it not for the particular connections of the fascia that have just been alluded to. I have, however, known the superficial fascia to give way, and the urine, then gravitating backward, to give rise to extensive sloughing in the ischio-rectal fossæ and about the nates, denuding the rectum.

The **Local Effects of Extravasated Urine** that has become acrid, decomposed, and concentrated by long retention, are most deleterious upon the tissues with which it comes into contact. It acts as a most intense irritant on all that it touches. The vitality of whatever portion of areolar tissue it infiltrates is quickly destroyed; the tissue becoming converted into a kind of putrid stringy slough, intermixed with and soddened by a quantity of fetid dark-coloured acrid pus and urine. The ravages of extravasated urine are often extensive; the urethra giving way suddenly behind the stricture, the fluid is driven with all the force of the over-distended bladder into the perinæum, and thence rapidly finds its way through the scrotum upwards. Rapid swelling and infiltration, partly urinous, partly inflammatory, take place in the scrotum and penis; these parts become enormously distended, red, and œdematous. The skin is speedily affected, becoming of a dusky-red or purple colour, and then falling into a state of gangrene, sometimes with emphysema. In this way the testes may become denuded, and the cords exposed. It is remarkable, however, if the patient survive these destructive effects, with what rapidity repair goes on in this region. It is seldom that infiltration extends higher than the groins, or the anterior portion of the abdominal wall; but it may reach the costal cartilages before proving fatal.

The **Constitutional Disturbance** is always very great. At first there is high fever, with a rapid full pulse; but the symptoms speedily assume the form met with in acute septic poisoning. The tongue becomes brown and dry; there may be vomiting; the pulse becomes small and very rapid; muttering delirium sets in, ending in insensibility, and death quickly follows.

The **Treatment** consists in making a free and ready outlet for the urine as early as possible. This should be done, as soon as extravasation is known to have occurred, by a deep incision into the middle of the perinæum. As soon as any pain and throbbing, with diffused swelling occur in the perinæum, with redness and more or less œdema of the scrotum, the patient should be drawn to the end of the bed and placed in the position for lithotomy. The Surgeon should next introduce his left index-finger into the rectum, so that the gut may not be wounded, and then pushing a long sharp-pointed bistoury deeply in the raphé of the perinæum, cut upward to a sufficient extent into the extravasation, and in the direction of the urethra. A catheter should then, if possible, be introduced, secured in the bladder, and left unplugged, with an india-rubber tube attached; in this way no further extravasation can occur, an outlet will be afforded to matters already effused, and the greater part of the urine will commonly be found to escape after a time by the aperture thus made. Should the case not be seen until extravasation has spread widely, a free incision should be made not only into the perinæum, extending to the aperture in the urethra, but also into the scrotum on each side of the septum, into the penis, and wherever else swelling is observed. The sole chance of safety for the patient lies in making these free incisions, through which the parts may, to a certain extent, empty themselves. However extensive the infiltration and serious the mischief may be, we need not despair of the patient if a free outlet can be obtained for the acrid and putrescent urine;

and in order to secure this, the infiltration must be followed by incisions as high as it extends. The parts must be covered with some warm and moist antiseptic dressing, the best being boracic acid lint moistened with warm boracic acid lotion, and at the same time they should be well dusted with iodoform. If this be not at hand the surface may be greased with carbolic oil (1 in 10), or terebene and oil and fomentations made of oakum wrung out of boiling water may be applied. These applications are cleaner than poultices, and should always be preferred. The patient will often experience great relief from frequent hot hip-baths, Condy's fluid or boracic acid being added to the water. In this way the parts can be most thoroughly cleaned without pain to the patient.

If the patient survive the immediate impression upon the system produced by the gangrene and the urinary infiltration, he must be prepared to go through a severe trial to his constitutional powers, in the separation of the sloughs, the profuse discharge, and other sources of irritation that are set up. During this period he will require abundant support—the brandy-and-egg mixture, ammonia and bark, with any nourishment that he can take; and much attention should be paid to the removal of the sloughs, to providing a ready outlet for discharges, and to keeping the patient as clean and as free from all local irritation as possible.

Perinæal Abscess.—By perinæal abscess is meant a collection of pus in the perinæum situated under the deep layer of the superficial fascia of this region. It is the confinement of the pus by the fascia which gives these abscesses their special character. Owing to the attachments of the deep fascia which have just been described, the pus formed in connection with the urethra is shut off from the ischio-rectal fossa, just as extravasated urine is. If the abscess be left unrelieved, it may burrow widely around the bulb and along the urethra before it reaches the surface by perforating the fascia. It is very important, therefore, that such abscesses should be opened early.

The chief forms of perinæal abscess met with are the following:—

1. **Abscesses arising from Suppuration in a Lacuna or Follicular Gland.**—These have already been described as an occasional complication of gonorrhœa. They are met with also in stricture. They may point slowly towards the surface, without actually communicating with the urethral canal. In other cases they open into the urethra, and then run the same course as abscesses commencing from the canal.

2. **Abscesses commencing from Ulceration in the Urethra behind a Stricture.**—These arise in the dilated pouch behind a tight stricture. As before stated, the mucous membrane at this part is thickened and opaque, and often pigmented, showing evidence of chronic inflammation. The openings of the ducts are dilated, sometimes giving the whole surface a reticulated appearance. The ulceration commences in one of the hollows thus formed. The inflammatory consolidation of the surrounding tissues prevents general extravasation; but the pressure during micturition and the constant presence of retained urine causes gradual extension of the cavity till a distinct abscess is formed discharging imperfectly into the urethra. Such an abscess slowly extends till it reaches the surface. It then bursts its cavity, contracts to a narrow channel, and thus an urinary fistula is formed. At any period before it bursts superficially, its wall may be ruptured during a violent effort at micturition, and diffuse extravasation of urine may result.

3. **Abscesses from Injuries by Instruments.**—These occasionally arise from false passages made with a catheter or bougie ; they may also follow forcible dilatation or internal urethrotomy. More rarely they result from inflammation and ulceration of the mucous membrane around an instrument tied into a tight stricture. These abscesses usually form rapidly. If resulting from a false passage behind a tight stricture, they may lead to extravasation of urine ; but under other circumstances, as there is a free passage through the urethra, this is not likely to occur. If the injury is in the bulbous or spongy portion, the pus may burrow forwards along the urethra under the accelerator urinæ, and appear at the root of the penis in front of the scrotum.

4. **Suppuration of Cowper's Gland** is an occasional cause of a perinæal abscess. It may occur from the irritation of a stricture, but far more commonly it is met with during the acute stage of gonorrhœa. The gland can at first be felt as a tender knot on one side of the middle line near the bulb. This gradually increases and becomes more tender, and at last fluctuation is felt. This form of abscess can be recognised, if seen early, by its situation, and by the fact that it is distinctly on one side of the middle line. At a later period it may burrow widely round the bulb and in the perinæum, so that its exact origin cannot be determined. It usually causes some difficulty in micturition.

5. **Prostatic Abscesses** may, as before stated (p. 1106), occasionally point in the perinæum.

It will be seen that there are two distinct classes of perinæal abscesses ; those that communicate with the urethra, and those that do not. The former usually end in urinary fistula, the latter do not.

The **Characters of a Perinæal Abscess** are those of a hard, rounded, elongated or oviform mass, situated in front of the anus, extending along the urethra, or perhaps occupying to some extent one side of the perinæum. Fluctuation is not to be felt so long as it is bound down by the superficial fascia ; when it bursts beyond its limits, then that sign may be met with. But so long as it is under the fascia the abscess will be found to be surrounded by so dense a mass of indurated tissue, and so tightly bound down, that fluctuation, or even elasticity, is not appreciable by the most practised finger.

Treatment.—The usual routine treatment of local sedatives, fomentations, and poultices, are of no avail in these cases. When once pus has formed in this situation it must be freely evacuated. No good can possibly come of delay, and every possible harm may result from the infiltration of pus among the important tissues of this region. The Surgeon must not wait for fluctuation, but when once the hard mass has fully formed must make a free incision into it. For this purpose he must keep in the mesial line, or as close to it as possible ; for in all perinæal incisions "*medio tutissimus*" must be his motto.

Urinary Fistulæ commonly form in the perinæum and scrotum, as the result of abscess in these regions communicating with the urethra ; occasionally, however, they are met with in other situations, as in the groin, the anterior abdominal wall, or the inside of the thigh. They usually communicate with the membranous portion of the urethra, but occasionally occur anterior to this. In number they vary considerably ; when occurring in the scrotal and penile portions of the urethra, they are usually single ; but when in the perinæum, they are often rather numerous, several apertures being occasionally met with about the perinæum, scrotum, and nates. In one case Civiale found as many as fifty-two. Their size also differs considerably; some admitting only the finest probe, whilst others are large cloacæ. In a case under my care, the patient had a tunnel of this kind in the groin that would readily admit three fingers. They are usually tortuous, elongated, and narrow; sometimes constricted externally and more widely dilated behind. The surrounding parts are greatly condensed; the whole of the scrotum and penis is enormously enlarged, indurated, and almost cartilaginous in structure. The urine may escape almost entirely through the fistulæ, scarcely any being discharged through the urethral orifice; or there may be but a slight exudation from the fistulous openings.

The **Treatment of Urinary Fistula** varies according as it is complicated with stricture, and as it is situated in the anterior or the posterior part of the canal.

If there be a stricture, this, as the cause of the fistula, will require removal either by dilatation or by the perinæal section. If the stricture be not very tight and hard, dilatation commonly succeeds; the instrument being introduced every second or third day, until the urethra is dilated to its normal size, when the fistulous tracks will in most cases close. In some instances, however, the frequent introduction and withdrawal of the catheter is a source of irritation, and then it had better be left in. When this practice is adopted, a moderate-sized elastic catheter should be used. If this be too small, the urine will flow between it and the sides of the urethra, and thus escape through the fistulæ; if too large, it stretches the urethral orifice of the fistula injuriously.

If the stricture be very tough and irritable, the better plan is to perform urethrotomy at once, as much time and pain are thus saved. In the majority of instances, internal urethrotomy with Civiale's instrument appears to me to be the safest and simplest procedure, and I have very advantageously practised it in such cases. But if the fistulæ be very numerous, so as to riddle the perinæum and scrotum in all directions, the better plan is to perform perinæal section. In this way we not only divide the stricture, and thus at once remove all obstruction, but give a free exit to the urine, which, instead of escaping by narrow and sinuous passages, finds its way out readily through the new aperture that has been made, and this will eventually granulate and heal by the second intention.

The fistulæ, especially if small and recent, will sometimes heal kindly enough after the removal of the obstruction; but if extensive, old, and cartilaginous, they are of course little disposed to repair; and although the cause that in the first instance gave rise to them may be removed, yet they constitute an independent affection which requires special treatment.

The special treatment for urinary fistula must vary according to the size of the canal, but more particularly with regard to the part of the urethra with which it communicates; whether it be a *Perinæal*, a *Scrotal*, or a *Penile* fistula. But in all cases, and wherever it be situated, there is one most important point to be attended to, viz., never to let the fistula be disturbed or irritated by the passage of urine over or through it, or it will never heal. Hence the urine must always be drawn off with the catheter, which the patient should be taught to pass for himself.

If the fistula be *Perinæal*, and of small size, a probe coated with melted nitrate of silver, or a wire made red-hot in the ordinary way, or by the galvanic current, and passed down it occasionally, may cause its contraction. If it be large, the edges of the fistula should be freely rubbed with the nitrate of silver, or deeply pared and brought together by quilled sutures, after which the urine should be drawn off whenever required by a catheter. If the fistulæ be large and very numerous, it will be better to pass a grooved director down the principal ones, and slit them up so as to throw the several sinuses into one.

When the fistula is *Scrotal*, it often requires to be laid open, and to be made to granulate from the bottom, when it may be found to communicate with a large sloughy and ill-conditioned cavity in this situation.

When *Penile*, the fistula is usually much more troublesome to heal; its edges are thin, and the track is short and shallow. **Urethroplasty** may in such cases be advantageously practised. Operations of this kind require for their success very careful management and minute attention to detail; they very commonly fail in consequence of a small quantity of urine or of mucus escaping through the wound, and thus interfering with union of its lips.

In order to prevent this accident, which is fatal to the success of the operation, the patient should be taught to pass a catheter, and thus to draw off his own urine after the operation as often as necessary; or an assistant must do this every third or fourth hour. Should this, however, not be practicable, a full-sized gum-catheter should be passed into the bladder and properly secured there. It should be left without a plug, so that no distension of the bladder and consequent likelihood of escape of urine between the urethra and the instrument may take place. In order to prevent urinous effusion over the integuments of the penis and scrotum, a vulcanized india-rubber tube should be attached to the end of the catheter, by which means the flow of the urine is directed away from the patient.

Urethroplastic operations may be varied according to the seat and extent of the fistulous opening. If the fistula be in the *perinæum*, the parts around being thickened and indurated, its closure may often be induced by freely and deeply paring the edges, and then bringing them together with the quilled suture, or by Sims's button.

When the fistula is *scrotal*, the edges should be freely pared, and the parts around widely dissected up so as to form large and thick flaps of cellulo-cutaneous tissue, which may be brought and held together by metallic sutures or shotted clamps. In this way, if union be not obtained throughout the whole length of the fistula, it may be to a partial extent; and, after a time, a second or a third operation will complete the cure.

When the fistula is *penile*, the difficulties in effecting closure become immensely increased. This is owing to the thinness of the integumental structures and the absence of subcutaneous areolar tissue in this region, so that there is not sufficient thickness of the parts for ready plastic union. In these cases, the Surgeon has a choice of four operations.

1. Nélaton has recommended the following procedure. The edges of the fistula having been pared, the skin around, to the extent of about an inch, should be dissected up subcutaneously through an opening made below the fistula, the edges of which must then be brought together by a few points of suture. The displacement of the skin covers in the aperture in the urethra and causes granulations to spring up, by which the fistula is closed (Fig. 965).

2. The edges of the fistula having been pared and the skin separated widely, lateral incisions may be made so as to take off all tension, and a slip of india-rubber may then be passed underneath the flaps of skin, in order to prevent contact with urine from disturbing the adhesions (Fig. 966).

3. Ricord, recognizing the fact that the occasional intrusion of a drop of urine between the freshened edges of the integuments brought together to close the fistula is the most common cause of failure of union, recommended that, in those cases in which a perinæal or a scrotal fistula happens to co-exist with a penile one, a catheter should be passed through the former into the bladder and left there during the whole of the operative procedures that are adopted for the closure of the penile fistula. Should no fistula exist in the perinæum, he has proposed, though I believe the operation has never yet been practised,

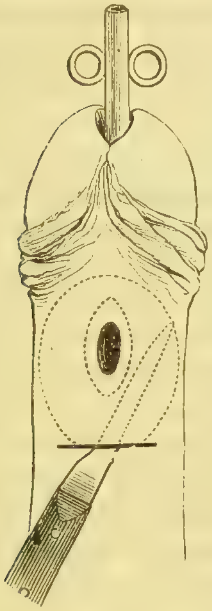


Fig. 965.—Urethroplasty. Nélaton's Operation : First Method.

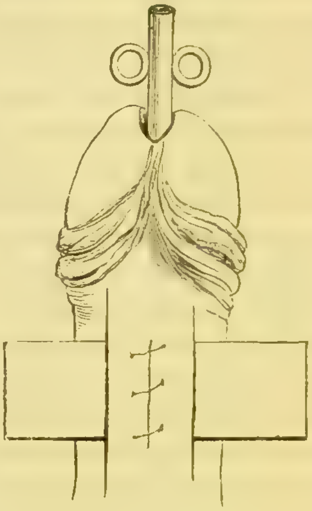


Fig. 966.—Urethroplasty. Nélaton's Operation: Second Method.

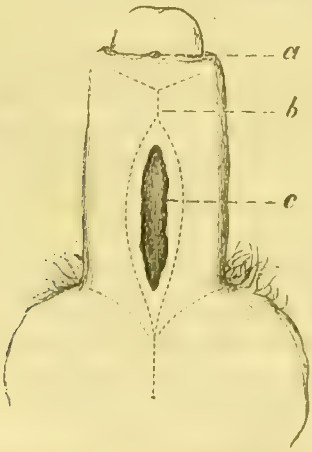


Fig. 967. – Urethroplasty. Clark's Operation : First Stage.

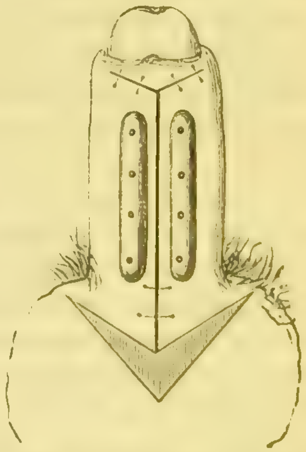


Fig. 968.—Urethroplasty. Clark's Operation : Second Stage.

to puncture the bladder—which would most conveniently and safely be done through the rectum—and to keep it emptied in this way until the penile fistula has been closed by one of the preceding operations, and then to allow the lower aperture to close spontaneously; or, if it were situated in the perinæum, to adopt surgical means for its occlusion.

4. Le Gros Clark has recommended and successfully practised the following operation. Having pared the edges of the fistula, he makes a tranverse cut through the integuments of the penis, about an inch in length, above and below it. He then dissects up the flaps of skin so bounded, and brings them together by means of clamps or the quilled suture. By this operation a wide raw surface from each side is brought into contact, instead of a mere raw edge of cut integument, and there is consequently a greater chance of successful union resulting (Figs. 967, 968).

In all operations of this kind union will be promoted by keeping the part constantly bathed with a concentrated cold solution of boracic acid. In this way decomposition of any mucus or urine that may accidentally find its way to the wound is prevented, and at the same time the lotion is so unirritating that it does not interfere with union. The lotion is best applied by means of a piece of boracic acid lint, which must be frequently wetted and changed. If the urine can be efficiently kept from the wound, a dry dressing of iodoform or salicylic wool will be found the best.

Stricture of the Female Urethra is rare. When it occurs, it is seated at the external orifice, which will be found to be narrowed and sharp-edged. The disease is usually the result of gonorrhœa, but may be caused by a chancre at the orifice. The symptoms are the ordinary ones of irritability of the bladder, frequent desire to micturate, and some difficulty or delay in doing so.

The *Treatment* consists in the dilatation of the orifice by means of a two-bladed dilator.

URINARY VAGINAL FISTULÆ.

Præternatural communications between the urinary passages and the vagina commonly arise from injurious pressure upon the anterior wall of this canal during parturition, and consequent sloughing to a greater or less extent. They may, however, occur from idiopathic abscess, or from malignant disease involving those parts.

Varieties.—Urinary vaginal fistulæ are essentially of two kinds, according as the communication is established between the urethra or the fundus of the bladder and the vagina. Hence they may be divided into *Urethral* and *Vesical.*

Urethro-Vaginal Fistulæ are, so far as my observation goes, of most common occurrence; and this is readily explained by the fact that the urethra lies between the vagina and pubes and is therefore exposed to the most severe pressure. These fistulæ are usually of small size and linear. **Vesico-Vaginal Fistulæ** establish a communication between the neck or fundus of the bladder and the vagina. They are consequently situated further back than the other, and are usually larger and more ragged.

Results.—The existence of an urinary fistula in the vagina is always a source of the greatest discomfort and distress to the patient. The dribbling of urine through the præternatural aperture is generally continuous; although, if this be situated far back, it may be somewhat intermittent, a flow taking place as the lower portion of the bladder fills. The incontinence of urine thus produced gives rise to irritation and excoriation about the external parts, and occasions a strong ammoniacal odour to hang about the patient.

The precise seat and extent of the fistulous opening may be ascertained by placing the patient on her knees opposite a good light, and holding aside the posterior and lateral walls of the vagina with bent spatulæ; when the anterior aspect of that canal will have a tendency to protrude, and thus to expose the fistula, at the same time that the introduction of a bent probe, or of a female catheter, into the urethra, will guide the Surgeon to the artificial opening in the urinary passage. By means of the duck-billed speculum (Fig. 969), the fistula can be brought into view equally well if the patient be placed in the lithotomy position.

Treatment.—When the aperture is small, about a line or two in diameter, and more especially if urethral, its closure may best be effected by touching the edges of the aperture with the galvanic cautery or a red-hot wire, and repeating this application once a fortnight or three weeks, until a cure is effected by their gradual contraction. This little operation is most conveniently performed by placing the patient in a kneeling posture, and then holding aside the posterior and lateral vaginal walls by means of the duck-billed speculum, when the opening will be fairly brought into view. The operation can be rendered painless by the application of cocaine.

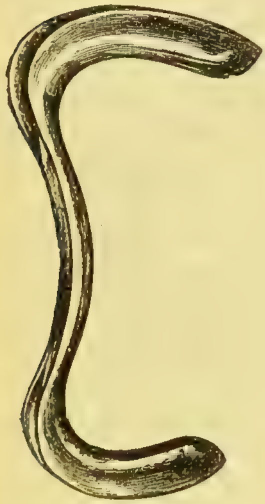


Fig. 969.—Duck-billed Speculum.

When the fistula is larger, and especially when vesical, its cure can be accomplished only by paring the edges, and bringing them together with sutures, and thus attempting to procure union by the first intention. In effecting this, however, two difficulties present themselves—the sutures either cutting their way out too soon, or the trickling of urine between the freshly pared edges interfering with adhesion. In order to overcome these difficulties, a variety of ingenious contrivances have been introduced by different Surgeons; amongst which may be especially mentioned the clamps of Marion Sims and Baker Brown, and the button-suture of Bozeman. To Sims especially is due the great merit of having substituted silver wires for silk sutures in this operation, by which the probabilities of a successful result have been very greatly increased.

Before the operation, the bowels should have been freely opened by castor-oil and an enema. It was formerly recommended that no anæsthetic should be given, as its administration makes it difficult to place the patient in the most convenient position, on the knees and elbows, with the buttocks well raised and the head low. As, however, the operation is tedious and painful it is better to give an anæsthetic, and no difficulty will be found in performing the operation with the patient lying on her back in the lithotomy position if the pelvis be well raised on a pillow. It is of great moment that the parts should be freely exposed. This is best done by means of the "duck-billed" speculum (Fig. 969), by which the posterior wall of the vagina is well drawn back and out of the way of the operator, and light is reflected on the fistulous opening. The edges of the aperture are now to be freely pared. This is best done by seizing them with a hook-forceps or a double hook, and dissecting off the vaginal mucous membrane to the extent of about a quarter of an inch all round, by means of a fine small scalpel or angularly set knives (Figs. 970, 971) and scissors properly curved. The dissection should be carried towards the fissure, and especial care taken that the angles are well cleared of mucous membrane.

After the edges of the fistula have been freely pared, and all bridles or cicatricial constrictions divided, sutures of silver are passed across the lips of the wound. These wires may most conveniently be passed by means of the hollow needle (Fig. 972); or, if this be not at hand, a silk thread may be passed by a nævus- or cork-screw needle, a full half inch from the freshened edge of the fistula, and brought out through a corresponding point on the other side of the opening, without having transfixed the mucous membrane of the bladder. As many threads as necessary having been passed in this way, a piece of silver wire about eighteen inches long is attached to the silk, which is then drawn out, leaving the wire to occupy its place, so that its centre corresponds to the fistula, and both ends hang out of the vagina. Sims then passes the uppermost free ends through holes made in a narrow leaden bar, on which they are clamped, by having split shot fixed upon them in the same way as is done on a fishing line. The unclamped wires are now drawn down until the bar is pulled close to the upper suture holes ; and a second clamp is then fixed to these ends and is pushed up against the lower suture apertures. In this way the edges of the fistula are brought and held together on each side by a clamp, which may be allowed to remain in from seven to ten days. The clamps may then be removed by clipping off the flattened shots from the anterior one, which is thus detached from its bed. The posterior one, with the wires attached, may then be hooked up, pushed backwards, and lifted out of the vagina with forceps. Instead of a clamp, Simpson used a splint made of annealed iron wire, which surrounds and supports the tissues around the fistula. In most cases, however, where the fistula is of but moderate size, the clamp and splint may be dispensed with, and the edges of the opening brought together with the suture-wires only.

Figs. 970 and 971.—Knives for Paring the Edges in Vesico-Vaginal Fistula.

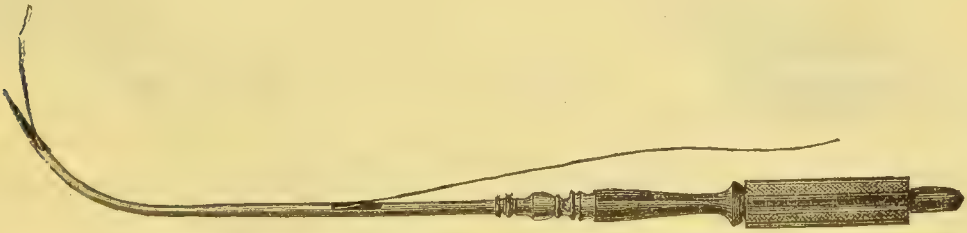


Fig. 972.—Hollow Suture Needle.

In the after-treatment, especial attention is required; and here the great point is to prevent contact of urine with the edges of the fistula. With this view a catheter should be introduced, and worn in the bladder, so that no urine may collect in this organ. For this purpose, Sims invented a very ingenious catheter, represented in the annexed cut (Fig. 973) which may be worn with more comfort, and with less chance of slipping, than the ordinary instrument. After the patient has been put to bed, and the catheter introduced, a full opiate should be given, and continued throughout the treatment, with the view of preventing the action of the bowels, a point on which Sims lays much stress. It is very seldom that they require to be opened for ten or fifteen days, provided the patient be kept on a suitable diet. During this treatment the catheter may be removed once or twice a day, in order to be cleansed and to be kept free from phosphatic or mucous accumulations; and free ablutions of the external genitals by sponge or syringe and warm boracic acid lotion should be practised during the whole of the treatment. After the removal of the sutures, Sims advises that the catheter should be continued, and great care taken that the patient do not move too soon, lest the weak cicatrix be strained.

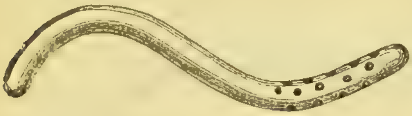


Fig. 973.—Marion Sims's Catheter.

A very simple and successful mode of closing these fistulæ has been invented by Bozeman, by what he terms the "button-suture." After paring the edges of the fistula, and passing silver wires across in the usual way, he draws the parts together by passing both ends of the wire through an aperture in a steel rod, which being carried along them closes the opening. A thin leaden plate, "the button," properly perforated down the middle, is then slipped along the wires so as to cover the fistula (Fig. 974); and split shot having been pushed along, their free extremities are pressed tightly against the button, the wires are then properly nipped, and the apparatus left on for about ten days (Fig. 948); the shot are then cut away, the leaden plate is carefully lifted off, and the suture wires, having been straightened out, are withdrawn.

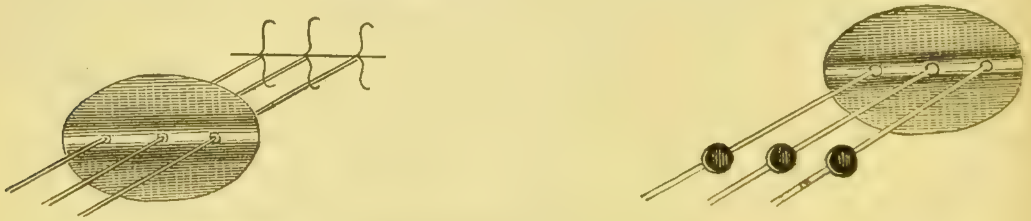

Bozeman's Apparatus for Button Suture.

Fig. 974.—Application of Plate.

Fig. 975.—Application of split shot.

Whatever kind of suture may be employed, it is always of great importance that the edges of the fistula be brought together *transversely* to the long axis of the vagina. Should the abnormal aperture be close to, or even implicate, the cervix uteri, this part may be drawn down and transfixed by the sutures, thus adding materially to the support of the posterior lip of the fissure.

TUMOURS IN THE URETHRA.

Small **Polypoid Tumours** are not unfrequently met with inside the urethral orifice. They have occasionally a gonorrhœal origin, though they commonly arise irrespectively of such disease. They are always very vascular, and are most frequently met with in or around the female urethra, where they are of a bright red colour, bleed freely when touched, and are composed of extremely vascular papillæ ; they are commonly conoidal or oval, bordering the urethral orifice on one side, or even encircling it. They grow slowly, and seldom attain a larger size than that of a raspberry.

These vascular tumours are far less frequent in the male than in the female urethra. When they occur in men, they usually constitute a small granular florid mass inside the orifice of the canal.

When seated in or around the female urethra, these tumours not unfrequently give rise to very great and continuous irritation ; much pain during and after micturition, radiating through the whole pelvic region, attended by an admixture of mucus and a little blood in the urine, and, in fact, many of the symptoms of stone ; so that patients labouring under this affection are often sounded on the supposition of the existence of calculus.

Treatment.—Vascular urethral tumours may be removed in four ways :—by Excision, Ligature, Caustics, or the Actual Cautery.

1. **Excision.**—When situated within the male urethra, the tumours should be snipped off with a fine pair of curved scissors. When situated in or around the female urethra, if of small size and pedunculated, they may readily enough be removed with the scissors or dissected away ; the canal of the urethra being encroached on as little as possible. This operation is, however, always attended or followed by very considerable and continuous arterial hæmorrhage, which has even been fatal. Hence, when the tumour is large, and the patient weakly, excision should be practised with much caution. If it be done, the hæmorrhage may be arrested by the introduction of a catheter into the urethra, and by firm pressure on the bleeding surface by means of a pad of lint, supported by a T-bandage.

2. **Ligature** is not a convenient mode of removing these growths ; its application is difficult, very painful, and tedious.

3. **Caustics,** particularly strong nitric acid or potassa cum calce, may be very conveniently employed where the tumour is of small size and very vascular. In applying them, the upper wall of the canal must be protected by a broad director introduced along it.

4. The **Actual** or **Galvanic Cautery** is the most convenient agent for the removal of vascular tumours from the *female* urethra. By it they are at once destroyed without hæmorrhage ; and the eschar that is formed protects the subjacent raw surface from the irritation of the urine. If they be situated deeply within the urethra, and of small size, the galvanic cautery or a red-hot wire will most easily reach them ; but if they be at or around the orifice, I employ a small olive-shaped cautery. During its application, the surrounding parts may be protected from the action of heat by a piece of wet lint having a hole cut in the middle through which the application is made, and the wall of the urethra on the side opposite to the growth by a director or silver catheter, which should be retained after the operation. Care must be taken not to destroy more tissue than is absolutely necessary, lest a stricture of the orifice be left.

CHAPTER LXXIII.

DISEASES OF THE PENIS AND SCROTUM.

DISEASES OF THE PENIS.

Complete arrest of the Development of the Male Sexual Organs must be of very rare occurrence. I have seen only one instance of it. This was the case of a man ætat. 22, in whom the penis and scrotum were perfectly formed, but not larger than the organs of an infant a few months old. No distinct testes could be felt, but there was some thickened structure in the scrotum which felt like an undeveloped testis. The prepuce was long. There was some hair, but very little, on the pubes. This person had sexual desires, and, in fact, had engaged himself to be married when his condition led to a surgical examination. He told me that he had erections, when the organ became about an inch or an inch and a half long, and that there was occasional emission of a glairy fluid. He was fair, fresh-coloured, round-faced, fat, and had smooth rounded limbs, more like those of a stout girl than of a young man. His voice was weak and feminine in tone. He led a sedentary indoor life, but said that he was strong and capable of ordinary physical exertion.

Congenital Malformations.—Adhesion of Penis to Scrotum. I have once, and once only, met with a very curious malformation of the genital organs, the penis being tied down by its under surface to the scrotum, so as to lie in a deep sulcus between the testes. In this case the raphé of the scrotum appeared to be continued in a narrow rather firm band upwards to the under surface of the penis, so that this organ was always bent or bowed downwards. The patient, a man of 30, passed his urine downwards, apparently from the under surface of the scrotum; during erection the penis curved up in a semicircular form, the convexity upwards, the glans being tightly tied down to the scrotum by the narrow tense band continued up from the raphé. In fact, the condition of this organ was very like that which is met with in the tongue when "tongue-tied." This malformation was remedied by cutting through the frænum which tied the penis down, and thus liberating the organ.

Hypospadias consists in a cleft condition of the under surface of the penis. Up to the tenth week of intra-uterine life the external organs of generation are alike in the male and female. At this time the urogenital aperture forms a narrow slit wider behind than before, at the anterior extremity of which is a small eminence representing the rudimentary penis or clitoris. In the female the urogenital aperture remains unclosed and the external folds of integument forming its lateral boundaries enlarge, forming the labia majora which contain the vascular bulbs corresponding to the corpus spongiosum of the male. These remain separate and distinct, but a small isolated portion becomes united in the middle line, forming the glans of the clitoris. In the male the two sides of the urogenital aperture unite in the middle line, forming the scrotum, and the bulbous and spongy portions of the urethra. At the same time the small eminence which in the female becomes the clitoris, develops into the penis. The vascular bulbs, which in the female remain separate in the labia, unite along the middle line in the male, forming the bulb of the corpus spongiosum. In the female no corpus spongiosum exists in the clitoris, the glans being an isolated nodule of erectile tissue. In the male the erectile tissue is continuous around the urethra from the bulb forwards.

Hypospadias consists in an arrest of the union along the middle line, and in proportion to the degree of the malformation the male organs come more closely to resemble the female in appearance. Hypospadias appears in three degrees. In the simplest form the glans is cleft along its under surface, the foreskin also showing a corresponding gap. In the second degree the corpora cavernosa and glans are well-developed, but the urethra is cleft to the root of the penis and the corpus spongiosum is wanting between the bulb and the glans. The penis thus resembles a large clitoris. The under surface shows a furrow in the line of the urethra usually covered by a moist mucous membrane. Between the glans penis and the point at which the urethra terminates, in the place of the absent corpus spongiosum a firm dense band of fibrous tissue is often present, somewhat resembling in hardness and tension the cicatrix of a burn. In these cases when erection takes place, the organ assumes a crescentic shape, with the convexity upwards, the tense hard cord that has just been mentioned stretching across its arc like the string of a bow, thus rendering connection impossible, and the sufferer practically impotent. The third and most extreme form of hypospadias is when the scrotum also is cleft and the urethra opens in the perinæum. This is usually accompanied by imperfect development of the penis, and most commonly by retained testicles. It is this malformation that has been erroneously considered to be an example of hermaphroditism. The cleft empty scrotum resembles the labia of the female, and the diminutive penis might readily be taken for a large clitoris.

Hypospadias affects only the parts in front of the membranous portion of the urethra, and consequently never leads to incontinence.

Treatment.—The first degree of hypospadias requires no treatment, the cleft glans being not even an inconvenience. Intermediate degrees between the first and second require treatment only if the urethra is so short that the seminal fluid will not enter the vagina during connection, or if there is a tight band beneath.

In the second degree of hypospadias, the first step is to dissect away the firm fibrous band which prevents complete erection. Some months after this has been successfully accomplished, and when the scars have become supple, the attempt may be made to close the urethra. In order to do this successfully, it is necessary to provide an epithelium-covered lining for the new urethra. Many methods have been suggested for doing this, but by far the best is that adopted by Anger, which is an adaptation to hypospadias of Thiersch's operation for epispadias. It is thus performed. An incision is made parallel to the groove representing the urethra, and half an inch from its right margin, a transverse incision from each end of this is made up to the edge of the urethral groove. The flap thus marked, which we will call the right flap, is then dissected up, leaving it attached along the margin of the urethral groove. A similar flap is then raised on the left side, but on this side the incision is carried along the left margin of the urethral groove, and the flap turned outwards, its attached edge being in the position corresponding to the free edge of the right flap. The right flap is now turned over so that its skin surface forms the lining of the new urethra. A number of fine stitches are then inserted in the following way. The needle is first passed through the base of the left flap from the skin surface, then through the free edge of the right flap from the raw surface towards the skin, then it is made to catch the left edge of the urethral groove, and finally passed again through the base of the left flap. In this way the edge of the right flap is held in position, and the stitches can be removed from the surface. When these have all been passed, they may be tightened. A similar number of stitches are then passed through the free edge of the left flap, by which it is attached to the skin of the penis at the outer edge of the raw surface from which the right flap was raised. The raw surfaces of the two flaps are thus brought closely into contact, and an epithelial lining formed for the new urethra. During the healing, a catheter must be tied in, and the bladder drained. A small fistulous opening will usually be left at the lower end, which must be closed by a subsequent plastic operation. Several successful cases of this operation have been recorded, and it seems to be by far the most efficient of the many methods suggested. The third degree of hypospadias admits of no treatment. The operation should not be performed on young children, as the parts are too small.

Epispadias.—The upper surface of the penis is less frequently fissured. The malformation commonly occurs in conjunction with extroversion of the bladder, but a few cases are recorded in which the penis only was cleft. This condition may be remedied to some extent by Wood's operation, described at p. 1080.

Phimosis.—The prepuce is not unfrequently the seat of malformation or disease. The condition of it in which it is so much elongated that it extends beyond the glans, while at the same time it is so much contracted that it prevents the proper exposure of this portion of the organ, is termed *phimosis.* This may be either congenital, or acquired.

In **Congenital Phimosis,** the penis is usually somewhat atrophied, and the development of the glans is prevented by the pressure of the narrow prepuce. The constricting band which prevents the retraction of the foreskin is always situated at the junction of the skin and the mucous membrane. In the majority of cases a long foreskin is simply a source of local inconvenience : but it may become a source of disease from a variety of causes. Thus, in children, retention of the sebaceous secretion—"smegma preputii"—becomes a source of local irritation and inflammation from decomposition. The irritation thus kept up (Fig. 976), leads to local excitement, and favours the early development of the habit of masturbation. In some cases the preputial orifice is so tight as to interfere materially with the discharge of the urine, which passes from the urethra into a kind of pouch between the glans and prepuce, distends this structure, and is then squeezed in a fine jet or in a scattered sprinkling stream through the narrowed preputial orifice ; and irritability of the bladder, often presenting symptoms simulating calculus, may thus be set up. Calculous concretions may form between the glans and the prepuce in such cases as these, and have been known to do so in enormous numbers. Whishaw, of Fyzabad, removed no fewer than 426 calculi, varying in size from a pin's head to a small bean, from this situation in the person of a native of India, 60 years of age, who came under treatment for what appeared to be a large tumour of the end of the penis, the true nature of which was not detected until in removing it the knife grated against the contained calculi. Various affections of the genito-urinary organs in children, such as incontinence, intermittent flow of urine, hæmaturia, priapism, &c., have been shown by Bryant to be caused by congenital phimosis. The straining in micturition may give rise also to hernia. Hydrocele of young children will also be found to be very frequently associated with phimosis. Sayre has pointed out the important fact that reflex paralysis and various forms of spastic contractions chiefly of the lower limbs are due to the same cause, being readily curable by circumcision. In addition to these I have seen general spasmodic affections in children resembling chorea, resulting from congenital phimosis. At more advanced periods of life I have known it to be a cause of sterility, the semen after emission being retained under the tight prepuce until erection had completely subsided. Congenital phimosis especially becomes a source of inconvenience in after-life if any gonorrhœal or venereal disease be contracted, as it renders exposure of the diseased part difficult or impossible, and interferes with the necessary treatment. In the opinion of some Surgeons, cancer of the penis, if not directly occasioned, is at all events predisposed to, by congenital phimosis.

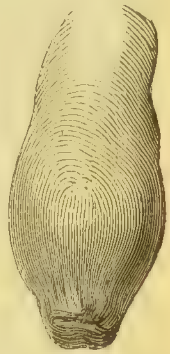


Fig. 976.—Irritated Congenital Phimosis.

Acquired Phimosis usually results from repeated attacks of inflammation, or of specific disease in the part, giving rise to solid œdema, or to false hypertrophy of the prepuce.

In elderly men, phimosis will sometimes slowly come on as a consequence of the irritation set up by cracks, fissures, or superficial ulcerations forming round the preputial orifice, which becomes narrowed, so as to prevent the glans from being uncovered. It is not uncommon in gouty subjects from repeated attacks of herpes preputialis. The preputial mucous membrane becomes thickened, and can be felt like a broad band under the loose and possibly slightly œdematous integument of the prepuce. This condition is a source of much irritation and annoyance, and requires relief by dilatation or by circumcision.

Treatment.—Every child who has a congenital phimosis ought to be circumcised ; and even those who, without having phimosis, have an abnormally long and lax prepuce, would be improved greatly in cleanliness, health, and morals by being subjected to the same operation ; and it would be well if the custom of Eastern nations, whether it be regarded as a religious rite or only as a time-honoured observance, were introduced amongst us. Phimosis, when not congenital, must be treated in accordance with its cause ; thus, if it have resulted from inflammation, that must be subdued ; if from venereal disease, that must be remedied, when perhaps the contraction and elongation will gradually subside. If, however, the phimosis, though acquired, be permanent, it should be subjected to operation.

A long foreskin without actual phimosis, if a source of annoyance to an adult, may easily be remedied by keeping it constantly drawn back. At first the tendency for the prepuce to slip forwards must be overcome by wrapping a piece of dry lint round it, and securing it by an elastic band, which must be just tight enough to keep it in position. After a few weeks the foreskin will retain the retracted position, and after a year or so will be found to have undergone considerable diminution in size.

Operations for Phimosis may be conducted on three plans; the elongated and contracted prepuce may be dilated, or slit up, or circumcision may be performed.

1. **Dilatation of the Phimosis** may be effected by putting the patient under chloroform, introducing a pair of forceps, and opening them widely, tearing through the narrow preputial orifice and tight funnel-shaped mucous membrane; or this may be slit up with a narrow tenotome on each side, and then dilatation practised. This procedure may be usefully adopted if the prepuce be not very long and tight, or if any objection exist to circumcision as too severe an operation.

In the acquired phimosis of old men, consequent upon contraction following cracks of the preputial margin, I have found that dilatation may safely and speedily be effected by the introduction of a two-bladed dilator, such as is used for the female urethra, which, being gradually screwed open, causes the indurated circle to yield.

2. **Slitting up of the Prepuce,** whether upon its upper or under surface, is, I think, an objectionable procedure, leaving the prepuce of its abnormal length, and more or less fissured and knobbed. In all cases I prefer circumcision as the simplest and speediest operation, and as leaving the most satisfactory result.

3. **Circumcision for Congenital Phimosis in Infants.**—It may be gathered from what has already been stated with respect to the evil effects resulting from congenital phimosis, that circumcision in this condition may be required to remove an elongated and possibly adherent prepuce, which occasions much local irritation, or which is the exciting cause of reflex and distant nervous disturbance of a paralytic or spastic character. So great are the evils resulting not only from congenital phimosis, but from an abnormally long, though not phimotic prepuce, that it is only humane and right from a moral point of view, to practise early circumcision in all such cases. This operation is easily and safely performed according to the Hebrew rite, which I have several times had an opportunity of witnessing, and which is done as follows. The child being held on the lap of an assistant, the operator draws the foreskin slightly forwards, and then grasps it just in front of the glans by drawing it through a slit in a silver guard. This is not held perpendicularly downwards, but is inclined from above slightly forwards and downwards, so as to avoid cutting the frænum as much as possible, and to slice off the prepuce in an oblique or quilled manner. This is done by one stroke of a broad round-ended knife. The mucous membrane is then torn open between the finger and thumb along the dorsum of the penis, and is turned back so as to be brought into contact with the cut edge of the skin. A strip of dry lint is then twisted round the organ in the sulcus behind the glans, so as to keep back the mucous membrane, and also to restrain hæmorrhage by its pressure. Union is perfect in a few days. This operation, which is practised on the eighth day after birth, is

very rarely attended by any ill consequences. I have, however, seen it in one case followed by fatal erysipelas, and have heard of another instance in which death occurred from hæmorrhage.

Circumcision in Boys or Adults may be most conveniently performed in the following way. The Surgeon restrains hæmorrhage during the operation, by tying a tape tightly round the root of the penis, or by compressing the organ in Clover's circumcision tourniquet (Figs. 977, 978), a most useful instrument, which can be slackened or tightened at any time. He next draws the elongated prepuce slightly forwards, until the portion of it which corresponds to the back of the glans is brought just in front of that structure. He then seizes the projecting prepuce immediately in front of the glans with a pair of narrow-bladed polypus forceps, which he gives to an assistant, who must hold them tightly ; or he grasps it and protects the glans by means of a plate (Fig. 979), which I have had constructed for this purpose. With one sweep of the bistoury he cuts off all that portion of the integument which projects beyond the forceps, which are then taken away (Fig. 980). It will now be found that he has removed only a circle of skin, but that the mucous membrane lining it still tightly embraces the glans ; this he slits up, by introducing the point of a pair of scissors at the preputial orifice ; and then, trimming off the angles of the flaps, he turns back the mucous membrane,

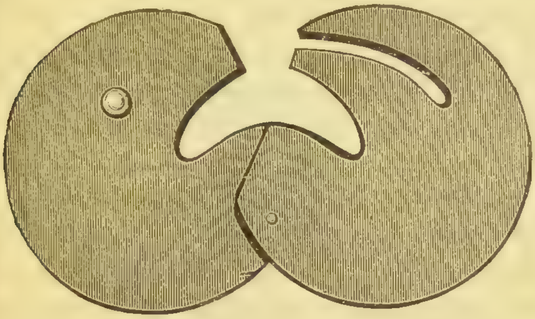


Fig. 977.—Clover's Circumcision Tourniquet (open).

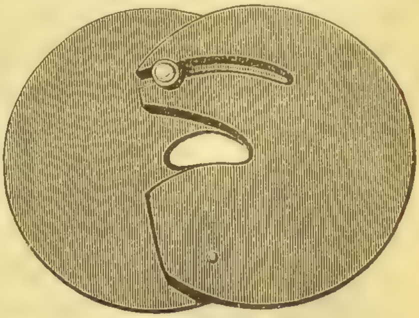


Fig. 978.—Clover's Circumcision Tourniquet (shut).

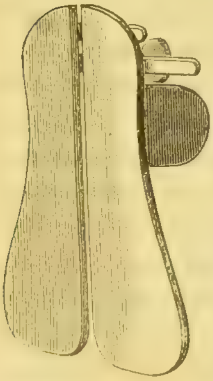


Fig. 979.—Instrument for holding the Prepuce in Circumcision.

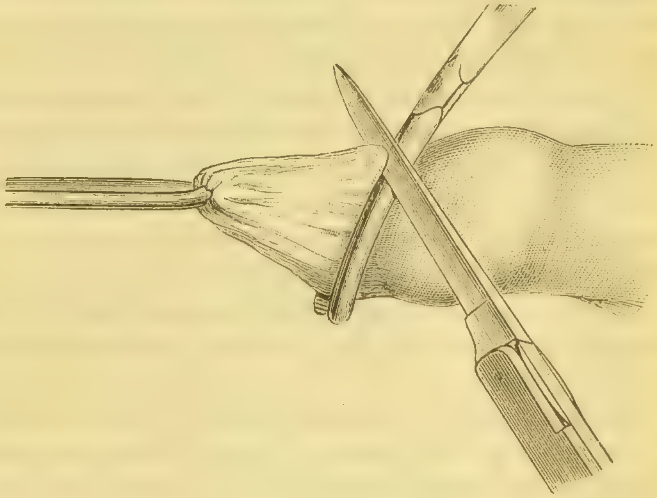


Fig. 980.—Circumcision in the Adult.

and attaches it to the edge of the cutaneous incision by a sufficient number of fine catgut sutures. Before introducing these, he will generally find it necessary to ligature a small artery on each side of the penis, and one or two in the frænum. The best dressing in children will be some simple ointment, such as boracic acid ointment, or the glans may be simply smeared with a little vaseline. After every act of micturition, the parts should be well sponged with boracic acid lotion or Condy's fluid and water. In the adult, union by first intention may often be obtained by a dry dressing of iodoform-wool thickly covered with collodion, so as to protect it from the urine. This may be left unchanged for four or five days. There is usually a good deal of swelling of the mucous membrane about the frænum, and some solid œdema usually remains for some weeks after the operation. This gradually subsides, and a linear cicatrix remains, which causes the patient no inconvenience. Adhesions between the prepuce and the glans are common ; these require to be torn or dissected through, but no inconvenience results from this slight addition to the operation.

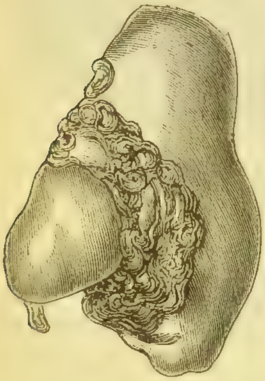


Fig. 981.—Sloughing of the Prepuce, and Protrusion of the Glans.

If sloughing of the prepuce have occurred, allowing the glans to protrude, as in Fig. 981, circumcision must be practised.

The chief points to be attended to in the performance of this operation, and on which its after-success is most dependent, are—1, That too much skin be not removed ; 2, That the mucous membrane be slit up to the base of the glans ; 3, That too much of it be not removed ; 4, That all bleeding vessels be tied with catgut ligatures, which must be cut short ; 5, That the mucous membrane be well turned back, so as to cover the gap left by the retracted skin ; 6, That all sutures be of catgut, which will be absorbed, and thus save the pain of taking them out.

Paraphimosis.—In *paraphimosis* the prepuce has been forcibly drawn back behind the glans, which becomes strangled by the pressure exercised by the preputial orifice, so that the parts cannot be replaced in proper relation to one another. This accident principally occurs in boys, or in individuals who have naturally a tight prepuce, and who, on uncovering the glans, find it difficult to get this part of the organ back. This difficulty is speedily and greatly increased by the swelling from congestion that is set up in the constricted glans.

Treatment.—This is sufficiently simple. The Surgeon should first try to reduce the swollen organ. He may often succeed in doing this by seizing the body of the penis between the index and middle fingers of each hand, and then endeavouring to draw the prepuce forwards, at the same time that he compresses the glans between the two thumbs and pushes it back (Fig. 982). Should reduction not be effected in this way, the constricted and strangulating preputial orifice must be divided. In doing this, the Surgeon will observe that the glans is separated from the body of the penis, by a deep and narrow sulcus, which is especially evident on the upper part of the organ. This sulcus, which is overlapped on one side by the glans, and on the other by a fold of integument—the swollen mucous layer of the prepuce—corresponds to the inner margin of the preputial orifice ; and it is by the division of this, in which the stricture is situated, that immediate relief will be given. This operation may readily be done by drawing the glans forwards, then passing the point of a narrow-bladed scalpel into the sulcus on the dorsum of the penis, and making a perpendicular incision about one third of an inch in length through the integuments at the bottom of the groove directly across it (Fig. 983). In consequence of the great stretching of the parts, the incision will immediately gape widely; so that, instead of being longitudinal, it will appear to be transverse; and then reduction of the glans may readily be effected.

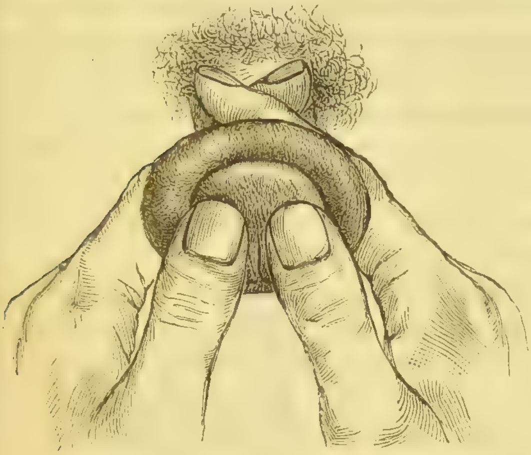


Fig. 982.—Reduction of Paraphimosis.

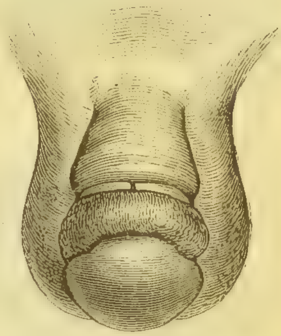


Fig. 983.—Incision in Operation for Paraphimosis.

Balanitis.—Inflammation of the prepuce commonly occurs as the result of local irritation from want of cleanliness, not unfrequently set up by a gonorrhœa. When confined to the prepuce, and constituting *balanitis*, that structure is much swollen, infiltrated, and reddened, and, while the inflammation lasts, continues in a state of phimosis. When the mucous membrane of the glans is affected as well, constituting *Posthitis*, there is a good deal of irritation and smarting, together with muco-purulent discharge.

Treatment.—The disease requires to be treated on ordinary principles. The continued application of lead lotion, with the internal administration of salines, will generally remove it; but in many instances the most effectual plan will be found to consist in rapidly sweeping the inflamed surfaces with a stick of nitrate of silver passed down between them on one side of the frænum, and carried round to the opposite side. If the patient is liable to repeated attacks, circumcision should be performed.

Herpes of the Glans and Prepuce is characterized by the formation of small vesicles or excoriated points upon the mucous membrane of this region, attended by much smarting and itching, and occurring chiefly in persons of a gouty habit of body, with an irritable mucous membrane.

Treatment.—This slight affection is often very rebellious to treatment. In many instances, local means alone will not suffice; for, though relief may be obtained by powdering the part with the oxide of zinc, or by using slightly astringent and cooling lotions, yet no permanent benefit will be derived unless constitutional treatment be adopted, modified according to the circumstances of the case.

Hypertrophy of the Prepuce occasionally occurs as the result of chronic irritation or disease; it is usually of limited extent, and requires no special treatment; but in some instances it may become so extensive as to require operative interference. The hypertrophy is due to solid œdema of the areolar tissue of the prepuce and of the body of the penis, the organ being greatly enlarged and becoming club-shaped. In these cases circumcision, with the excision of a V-shaped piece from the dorsum of the penis, will usually be found to leave a satisfactory result. But a greater magnitude than this may be attained. Thus Vidal has related and figured a case that had attained such an enormous size, that the organ reached to below the knees, and was as large as a thigh. This monstrous growth was successfully excised.

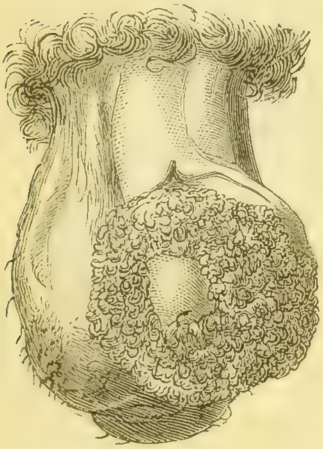


Fig. 984.—Warts on the Glans and inner surface of Prepuce, which is slit up.

Warts on the penis have already been described. They may attain a very large size, as in Fig. 984, and are best treated by being snipped off with curved scissors.

Horny Excrescences have been observed to spring from the glans penis. The most remarkable case of this kind on record is one by Jewett of Connecticut. It was that of a young man, in whom, after operation for congenital phimosis and the removal of warts, a horn grew from the left side of the glans penis, and attained a size of three and a half inches in length by three-fourths of an inch in diameter at the base. It could be handled and cut without pain, and the patient "was accustomed to amuse the inmates of the ward by lighting the end of the horn and allowing it to burn." It was excised, and did not return.

Persistent Priapism, lasting for many days, is occasionally met with, as the result in most cases of excessive venery, and more especially of violent coitus during intoxication. The erection of the penis is not accompanied by any sexual desire, but is attended with great pain, a sense of weight about the perinæum, much anxiety, and constitutional disturbance. The organ is singularly hard and unyielding. The pathology of this condition is obscure. By some it has been considered to be the result of extravasation of blood into the corpora cavernosa; by others, to depend on sympathetic or reflex nervous irritation. The effect of treatment would lead to the inference that the latter view is correct. Incisions into the corpora cavernosa to let out the blood supposed to be extravasated have been productive of no good, whilst the erection has rapidly subsided under full doses of bromide of potassium.

Gangrene of the Penis.—Sloughing of the integuments of the penis, to a greater or lesser extent, not unfrequently occurs in persons of broken constitution as the result of inflammatory phimosis, simple or gonorrhœal (Fig. 981); or in consequence of the invasion of syphilitic phagedæna, and indeed the glans and body of the organ may often be extensively destroyed by the latter cause. These various forms of the disease have already been described.

The true *idiopathic gangrene* of the penis is, however, a very rare disease: and Demarquay, who has specially directed attention to it, finds but few instances of it in the records of surgery. It has chiefly been met with in people of advanced age or of broken constitution, who, whilst suffering from some local affection of the organ, have been attacked by acute febrile disease, such as typhoid or small-pox, or have become the subjects of pyæmia. In some cases it is probably embolic. The disease, when affecting the body of the penis, is often fatal—possibly by hæmorrhage on the separation of the slough. When the glans only is attacked, the prospect is better. But in either case mutilation of the organ to a serious extent will result.

The *Treatment* of gangrene of the penis presents nothing special, with the exception of restraining hæmorrhage by means of the actual cautery, and preventing or repairing loss of substance in the urethral wall, if it be invaded by the disease and involved in the destruction resulting.

Fibrous Tumour of the Penis.—The penis may be the seat of fibroid and other tumours. The accompanying drawing (Fig. 985) is an illustration of one springing from the fibrous tissue of the corpora cavernosa which I removed some years ago from the under surface of the organ.

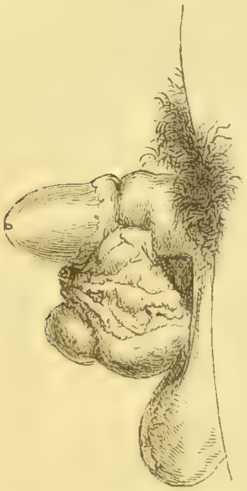


Fig. 985.—Fibroid Tumour of the Penis, successfully removed.

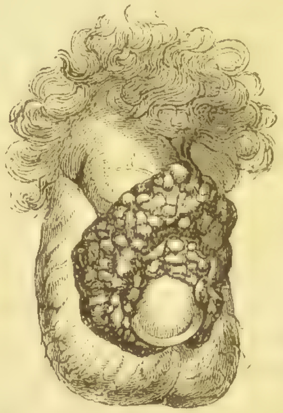


Fig. 986.—Warty Epithelioma of the Penis.

Cancer of the Penis.—The form of cancer met with in the penis is *Squamous Epithelioma.* It usually springs from the sulcus behind the glans and thence invades the neighbouring portion of the organ. It always commences in the anterior extremity of the penis, affecting the body of the organ only by extension from the original starting point. It appears in two forms, either as a flat tubercle or as a distinctly papillary growth. When it commences as a tubercle it appears as a hard pale reddish-white mass situated on the glans or between the prepuce and the glans. This increases in size and extends deeply into the organ. At last a crack forms and allows a serous discharge to exude which usually becomes very fetid. Ulceration then rapidly takes place. Sometimes the disease appears to be very distinctly localized; but after its removal it will usually be found to infiltrate the organ for a considerable distance.

The papillary form at first presents the appearance of ordinary warts (Fig. 986). It grows rapidly, and a deep-seated indurated base can be felt beneath it. Ulceration soon sets in with abundant foul discharge. At first the distinction from a simple growth is not easy to make, but the flat hard base infiltrating the glans will usually indicate its nature.

Cancer of the penis occurring under a long foreskin soon leads to such enlargement of the glans that the prepuce cannot be drawn back. It then causes a globular enlargement over which the skin of the prepuce is tightly stretched, and a foul serous discharge often tinged with blood escapes from the orifice. Finally the distended foreskin may give way and the fungating cancerous growth project through an ulcerating aperture in it. The glands in the groin are early affected.

Causes.—It has been supposed and with some show of reason, that congenital phimosis predisposes to the affection; probably by confining the secretions, and thus keeping up irritation of the part. Hey found that, of 12 patients with this disease who came under his observation, 9 had congenital phimosis; and Travers states that Jews, who are circumcised, are seldom subject to this affection. But as they are a limited community in this country, and as the disease is rare, we cannot draw any conclusive inference from this observation. It is, however, very probable that the papillary form of the disease often arises from the local irritation resulting from the accumulation of the secretion under a long foreskin. The nodular form of the affection, however, may occur frequently in individuals who have not suffered from this source of irritation; of this I have seen several instances.

Diagnosis.—Epithelioma of the penis requires to be diagnosed from *fungoid warts*. This may usually be done by comparing the indurated state of the malignant with the soft and lax condition of the non-malignant affection. From *chancrous induration* of the glans, the history of the case and the way in which it is influenced by treatment will enable the Surgeon to make the diagnosis.

Treatment.—The treatment of cancer of the penis will vary according to the nature and extent of the malignant affection. If the growth is limited in extent and especially if it is papillary in form the Surgeon may, if he see the case early, content himself with dissecting off the affected patch. Should the growth be more extensive and extend deeply into the substance of the penis the treatment must be conducted on the principles that guide us in the management of malignant affections wherever situated; viz., to remove the diseased organ at as early a stage as possible, whilst the affection is localized, before the glands are implicated and the constitution poisoned. In the penis this may readily be done by an operation that is simple in its execution and nearly devoid of danger. In many cases a return may take place, and that speedily, either in the part itself or in the neighbouring lymphatic glands; yet, even if this occur, it is clearly the duty of the Surgeon to rid the patient of a loathsome disease, and to put him in a state of comparative comfort for some time; the more so, as there is reason to believe that, in some instances, the disease may be entirely extirpated from the system, evincing no tendency to return. Indeed, I believe that amputation of the penis for cancer is more successful in its results than is the extirpation of malignant growths from most other situations. In some of Hey's cases, which continued under his observation, there was no recurrence of the disease for several years. I have seen several patients who, after a lapse of six or eight years, have continued free from a recurrence of the disease; and I have also seen a gentleman who had his penis amputated for cancer more than twenty-five years ago, and in whom no return has taken place. The fact is, that we see and hear of those cases in which a recurrence takes place; but those patients who remain free from a return of the affection do not divulge their infirmity; and it is exceedingly rare in hospital practice to find a patient come back with recurrent cancer in the stump of the penis, which he would certainly do if relapse took place. In those cases in which the operation is not successful, it has usually been delayed too long, the disease having already implicated the lymphatic glands in the groin, and thus contaminated the patient's constitution.

Amputation of the Penis is best performed with the knife, though the écraseur may be used if preferred. The operation should always be performed towards the root of the organ, so as to be well clear of the disease. Before proceeding to operate means must be taken to restrain undue hæmorrhage. This is best done by tying a narrow tape tightly round the root of the penis, or by encircling this part by Clover's tourniquet (Fig. 977), applied as in circumcision, only nearer to the pubes and more tightly. The operation may be done in various ways, but the following is perhaps as efficient as any. The penis being drawn well forwards a circular incision is made round it with a bistoury dividing the skin only. The corpora cavernosa are then cut carefully through from the dorsal aspect, care being taken not to wound the corpus spongiosum. If necessary a full-sized catheter may be introduced to define more clearly the limits of the urethra. The part of the penis beyond the section of the corpora cavernosa being drawn well forwards no difficulty will be found in separating these from the corpus spongiosum. Finally the corpus spongiosum is cut through half to three quarters of an inch nearer the glans than the incision through the corpora cavernosa. The bleeding is then arrested. There are usually five arteries requiring ligature: the dorsales penis, one in each corpus cavernosum, and one in the septum. In securing these, trouble is not unfrequently experienced in consequence of the retraction of the stump that is left. The danger of hæmorrhage scarcely exists if the tape or the tourniquet have been properly applied before the operation, as every artery should be secured before the compression is taken off. The projecting urethra is then slit up with a pair of scissors along the dorsal aspect. It is then spread out and attached by catgut sutures to the skin below and to the corpora cavernosa above. In this way the contraction of the urethral orifice, which is often a most serious source of inconvenience and even of danger to the patient after amputation of the penis, may with certainty be prevented. Hilton, who first pointed out the necessity of providing against this accident, recommended that the urethra should be slit along its under aspect, but if this be done the urine is directed downwards between the legs during micturition, while if the slit be made towards the dorsal aspect it is often projected somewhat forwards, and the patient can thus make water with less inconvenience. In performing the operation care must be taken that the skin is not dragged too much forwards, lest sufficient covering be not left. After the operation is finished the cut spongy tissue should be wiped over with a solution of chloride of zinc (gr. 40 to ℥j.), and the stump must be covered with a piece of lint moistened in boracic acid or some other antiseptic. After passing water the parts must be well bathed with some antiseptic solution. In this way septic infection, which may readily occur in so spongy and vascular an organ, may be prevented.

If the amputation be performed too high up infiltration of urine may take place into the scrotum, and to prevent this, it may be safer to introduce an elastic catheter after the operation, and leave it in for a few days.

When the écraseur is used it is better to divide the skin and the corpus spongiosum with the knife, the corpora cavernosa only being cut through by the wire. There is, however, little if any advantage to be gained by the use of this instrument, unless there is any special reason for avoiding loss of blood, as hæmorrhage is not usually a serious trouble in the operation.

If the glands in the groin are distinctly, but not too greatly, enlarged, an attempt should be made to remove them at the same time as the amputation of the penis is performed.

In a case extending too far back to allow the performance of the ordinary operation, Pearce Gould successfully removed the disease by dividing the scrotum and dissecting away the whole organ as far back as the crura, leaving an opening in the perinæum through which the patient subsequently passed water. This operation has since been repeated in many cases with success. It has been recommended to remove the testes at the same time, as they are somewhat in the way during micturition, but this seems hardly necessary.

If after amputation of the penis much inconvenience arises from the urine being passed downwards between the legs, it may best be avoided by following Ambrose Paré's advice of adapting a funnel, which may be made of metal, or ivory, to the pubes over the stump, and thus carrying the urine clear of the person.

Other Tumours besides cancer are occasionally met with in the penis. I have seen *Cysts* and *Nævi* situated under the prepuce ; and *Fibrous Tumour* may occur in the corpora cavernosa. Such morbid growths if small can readily be removed without injury to the rest of the organ ; if large, they may necessitate its amputation.

DISEASES OF THE SCROTUM.

Inflammatory Œdema of the scrotum is an erysipelatous inflammation of this region, and derives its chief peculiarity from the circumstance of its giving rise to great effusion into and swelling of the areolar tissue of this part and of the penis, with a tendency to the rapid formation of slough in it, by which the integument may likewise become affected to such an extent that the testes and cords become denuded. This disease usually originates from some local source of irritation, as fissures, cracks, or urinary extravasation (p. 952, Vol. I.). There is a peculiar and specific form of "inflammatory œdema" of the scrotum and penis, which is apt to occur as a sequence of small-pox and scarlet fever. In this form of the disease rapid and extensive infiltration of the parts occurs, with a tendency to speedy gangrenous disorganization of the areolar tissue and skin covering the organs of generation.

Treatment.—This consists in elevating the scrotum, fomenting it well, and making early and free incisions into it, particularly at the posterior and dependent parts of the scrotum and penis, with the view of relieving the tension to which the tissue is subjected by the effusion into its meshes, and thus preventing the liability to slough. Should this occur, the case must be treated on ordinary principles, when cicatrization will speedily ensue, however extensive the denudation of parts may be. The constitutional management must always be conducted in accordance with those principles laid down in the first division of this work, and with special attention to the maintenance of the patient's strength.

Hypertrophy of the Scrotum seldom occurs in this country, though Liston once had occasion to remove such a mass, weighing 44 lbs. ; but in some tropical regions, particularly India and China, it is of frequent occurrence, and may go on until it attains an enormous bulk, forming a tumour nearly as large as the trunk, and perhaps weighing 70 or 80 lbs., or even, as in one case recorded by Larrey, 200 lbs. These enormous growths are of simple character, and constitute the disease termed *Elephantiasis Arabum of the scrotum.* (See Vol. I., p. 1013.) Fig. 987 represents a tumour of this kind, weighing 40 lbs., which was successfully removed by Rogers of the Mauritius. It is taken from a photograph of the case, kindly sent to me by that gentleman.

Treatment.—Tumours of this kind necessarily require extirpation. In performing this operation, two points imperatively demand attention. The first is the avoidance of hæmorrhage, which in so vascular a region might easily be fatal. The other is the preservation of the penis and testes.

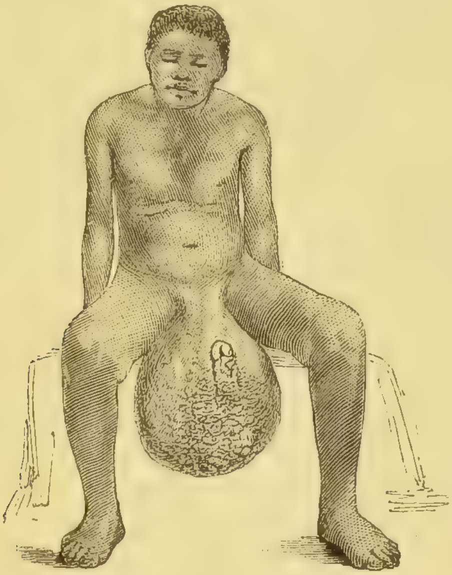


Fig. 987.—Elephantiasis of the Scrotum.

The avoidance of hæmorrhage may be effected by various methods, which may be employed singly or combined. The loss of blood may be greatly diminished by position, as originally advocated by O'Ferrall in 1844, the patient lying on his back and having the tumour raised above the level of the body for an hour before the operation. The tumour may at the same time be bandaged so as to compress its vessels, and thus empty them. This method does not affect the proximal hæmorrhage, which may be prevented by one of the following methods :—1. The application of the aortic compressor ; 2. Esmarch's bandage ; 3. The application of a screw-compressor to the root of the tumour. Either of these methods may be conjoined with position.

The use of the compressor is especially advocated by Dr. Turner, a medical missionary at Samoa, who has had vast experience in this operation, having removed no fewer than 138 of these tumours. The clamp used by Dr. Turner consists of two parallel bars of sufficient length, united by two long upright screws worked by nuts. After the tumour has been raised and emptied of its blood, the compressor is applied to the neck and screwed down tight when the operation is proceeded with.

The directions given by Dr. Turner for the safe performance of the operation are as follows:—The patient having been anæsthetized, the clamp applied, and the tumour emptied of its blood by pressure, the clamp must be screwed home. The tumour, if small, may then be raised by the hands; if large, two strong hooks should be passed deeply into the leathery skin at the bottom, and being attached to a block and tackle fixed to the ceiling, the whole mass must be raised so that its posterior part is brought into view. A couple of skin-flaps about 1½ inch long are then made here at its neck. The tumour is then lowered and allowed to fall forward. Two or three skin-flaps are now to be made from the front and sides of the tumour, the front flap being intended to cover in the penis when dissected out; one should be of sufficient size for this purpose. The lateral flaps are intended to cover in the testes. The penis must next be sought for. In small tumours where it lies superficially, it is easily found. In larger ones where deeply buried, it is best reached by slitting up the aperture through which the urine escapes, going in search of the glans penis, and then dissecting out the organ, which should be held up against the abdomen. The testes are now to be sought for by cutting diagonally, and with finger and knife they must be cleared and the cords followed up. By a few strokes of the knife the mass is now removed. A large number of vessels—from 30 to 40—may require ligature in the stump; they are tied as the clamp is gradually loosened. The skin-flaps are then brought together over the penis and testes, and the wound treated on ordinary principles. Some Surgeons object to the formation of skin-flaps with the view of covering in the penis and testes, as tending to favour recurrence of the disease. But as Dr. Turner very truly remarks, the skin on the neck of the tumour is generally healthy, being merely dragged down from the parts above the scrotum.

Epithelioma occasionally affects the scrotum; and, as it occurs principally in chimney-sweepers, it has been appropriately enough termed *Chimney-sweeper's Cancer.* This affection appears to arise from the irritation of the soot lodging in the folds of the scrotum (See Vol. I., p. 1048). It commonly commences as a tubercle or wart, which after a time cracks or ulcerates, presenting the ordinary characters of a cancerous ulceration. It rapidly spreads, involving at last the greater part of the scrotum, and perhaps invading the testis. After a time, the inguinal and pelvic glands will be affected; and the patient, if deprived of his covering of soot, will be found to be cachectic-looking.

The **Treatment** consists in excising widely the diseased portion of the scrotum, provided the inguinal glands be not involved, or the patient's constitution poisoned. The disease has a great tendency to return, and it is seldom that the patient long escapes with life when once he has been affected by it. This disease is much less common now than it was formerly, when "climbing-boys" were employed instead of machinery for the sweeping of chimneys.

CHAPTER LXXIV.

DISEASES OF THE TESTIS AND CORD.

MALPOSITION OF THE TESTIS.

The testes are, in the fœtus, lumbar organs lying below the kidneys, and in the normal condition descend into the scrotum a short time before birth. From some arrest of development, this descent may be retarded on one or both sides; and in other instances it is never completed. An undescended testis may continue to lie within the cavity of the abdomen; or it may find its way into the internal ring; or may become engaged in the inguinal canal, lying above the external abdominal ring, or it may project just beyond this, not passing into the scrotum. In these several situations it may remain quiescent; but it may become the seat of inflammation or of new growths, simple or malignant. It may also, when undescended, as has been stated at p. 851, Vol. II., become complicated with or mistaken for a hernia, and may present many diagnostic difficulties. Inflammation of the testis retained in the canal will be considered at p. 1206. When an undescended testis becomes painful or the seat of structural disease, it may require removal from the canal. The testis may be met with in other abnormal situations; thus some time ago I saw a case in which one of these organs was situated in the perinæum, close by the anus, having apparently missed the scrotum; and cases have occurred in which they have been met with in the interior of the pelvis. The organ may sometimes be turned hindside forwards, being retroverted, so that the epididymis is placed in front. In a case of this kind which I had an opportunity of examining after death many years ago, the epididymis and vas deferens were considerably larger than natural. If a hydrocele form in such a case, it will be seated behind the testis.

There is a very important question connected with malposition of the testis, viz. Is the organ when undescended prolific? There is reason to believe that it is not. Such testes are small, hard, and granular in structure; and, when they are examined under the miscroscope, spermatozoa are not found in them. When only one testis is undescended, the other one, being in its proper position, carries on the functions of the two organs; but when both testes are retained in the canal or in the abdomen, being undescended, the individual who is the subject of such malposition will most probably be sterile. He may have the usual erotic feelings, full power of erection, and of emission of a fluid; but the secretion will probably have no fecundating power. In the event of it being necessary to determine this point with certainty, the examination of a drop of this fluid under the microscope will demonstrate the presence or absence of spermatozoa, and so decide it.

Treatment.—In most cases a misplaced testis calls for no treatment. In children, the application of a horse-shoe truss above it may aid in its descent when it lies immediately outside the ring, but its effect is somewhat doubtful. Any attempt to bring the testicle down into the scrotum would be ineffectual, for in these cases it will be found that, although the vas deferens is usually long and lax, the vessels are too short to allow of any further displacement of the gland downwards. A testicle in the groin may, however, be so serious a source of inconvenience, as to call for some operation for its relief. This most commonly arises when it lies in the inguinal canal. In these cases the gland may occasionally be forced into the external ring and partly strangulated, causing intense pain till it is reduced. Under these circumstances, the ring may be closed by suture, as in the radical cure of hernia, or the gland may be removed. The latter is, perhaps, the preferable operation, as being the more certain.

When the testicle has missed the scrotum and passed into the perinæum, it may be a great source of pain from the frequent injuries to which it is exposed in sitting. As in these cases the cord is of sufficient length, the testicle may be put into its proper position without great difficulty. It must be dissected out, and left attached by the cord only. An incision is then made into the scrotum, the testicle placed in its proper position, and secured by a catgut stitch. The details of the operation must necessarily vary with the abnormal position from which the gland has to be removed.

NEURALGIA OF THE TESTIS.

A painful or irritable condition of the testicle may occur without any actual disease of the organ; the pain being seated either in the epididymis, which is the part naturally the most tender, in the body of the testis, or stretching along the cord to the loins and groins. It is usually paroxysmal, and is accompanied by great tenderness, and commonly by some fulness of the organ, which feels soft and flaccid; but it is difficult to make a proper examination, on account of the agony that is induced by touching the part. This disease occurs chiefly in young men of a nervous temperament, and is frequently associated with great mental despondency, often amounting to a suicidal tendency.

The **Causes** are obscure; in many cases the disease appears to be connected with a neuralgic temperament, but in others it is associated with some dyspeptic disorder, or may be dependent upon local irritation; thus external piles, or the pressure of a varicocele, will often give rise to it. In middle-aged or elderly men it is often of a gouty character, most commonly affecting the left testicle.

The disease is usually of a very chronic character. In some instances, however, it ceases spontaneously, after having lasted for weeks or months.

Treatment.—When the neuralgia is dependent upon constitutional causes, the treatment is extremely unsatisfactory. The administration of tonics, such as iron, zinc, or quinine, the local application of sedatives, as of atropine ointment or the tincture of aconite, may be of service. In other cases, cold bathing or douching will be beneficial; and, in all, keeping the part supported with a suspensory bandage will be advantageous. When it is due to gout the patient must be treated for that condition. In the event of there being any local irritation, that should be removed; thus I have known the disease to cease after the excision of external piles; and when it is connected with varicocele, proper measures must be adopted for the relief of that affection.

The application of glycerine and belladonna or of a mixture of equal parts of chloral and camphor may give relief.

In extreme cases, Sir A. Cooper recommended castration; but such a proceeding is altogether unjustifiable in a disease that is either constitutional, or dependent on local causes which are readily removable.

INFLAMMATION OF THE TESTIS.

Inflammation of the Testicle, considering the organ as a whole, may be of two distinct kinds, varying as to seat and as to cause. Thus it may be seated in the body of the organ, constituting *Orchitis;* or the epididymis may alone be affected, constituting *Epididymitis.* As to cause, it may be rheumatic, traumatic, or gonorrhœal, or may occur as a sequela of mumps.

Acute Inflammation.—The *Seat* of the inflammation, at the commencement of the disease, depends greatly upon the cause, which may be in the urinary passages or elsewhere. Irritation in any part of the urethra, occasioned by the passage of instruments, by the lodgment of calculi, or by gonorrhœal inflammation, usually causes the epididymis to be primarily affected, and the body of the organ to be inflamed in a secondary manner. When, on the other hand, the inflammation comes on from injuries, blows, strains, or other causes acting on the testis as a whole, the body is usually first affected. To all this, however, exceptions will often occur; and orchitis may supervene as the result of gonorrhœa, or epididymitis from a blow. The orchitis in such cases is in all probability a kind of constitutional affection, intimately associated with inflammation of other fibrous tissues, especially with gonorrhœal rheumatism; the inflammation of the epididymis, arising from gonorrhœa or other irritation of the urinary passage, appearing to result from direct extension of the morbid process along the vas deferens.

Symptoms.—These necessarily vary to a certain extent, not only according as the disease is of an acute or of a chronic character, but as it primarily affects the body of the testis or the epididymis. When it commences in the latter structure, it is the inferior globus that is commonly first affected; it becomes swollen, hard, and tender. The disease may be confined throughout to this part; but most frequently it invades the whole of the organ, which becomes uniformly enlarged and somewhat ovoid; it is frequently accompanied by a good deal of effusion into the tunica vaginalis, then constituting the *Acute Hydrocele* of Velpeau. As the inflammation subsides, the different characters presented by the enlargement of the two constituents of the organ again become apparent. The swelling is therefore due partly to general enlargement of the organ, but in some cases to inflammatory effusion into the tunica vaginalis; and this exudation may either be purely serous or partly coagulable.

The pain is always very severe, with much tenderness and a sensation of weight, and commonly extends up the cord into the groin and loin. It is generally greatest when the body of the testis is affected, owing probably to the enveloping fibrous tunic preventing the expansion of the organ. Hence it is often spasmodic and paroxysmal, extending up the course of the cord. There are usually considerable swelling and redness of the scrotum, with turgescence of the scrotal veins, and a congested state of the cord, with sharp pyrexia, nausea, and perhaps occasional vomiting.

As the disease subsides, the body of the testis first resumes its normal character and shape, the epididymis often continuing hardened and enlarged for a considerable period. In fact, the induration that forms in the epididymis may be permanent, implicating the whole or a portion of its convolutions.

Gosselin has shown that this induration of the epididymis following inflammation frequently causes complete obstruction of the canal, and if occurring on both sides produces sterility. In 19 such cases he found spermatozoa absent from the semen, and the patients consequently incapable of procreation, although the appearance of the testes and of their secretion was scarcely altered, and the virile powers of the patients remained unimpaired. Curling also mentions several such cases, and points out the necessity of continuing the treatment of epididymitis until the last trace of induration has disappeared. At a later period, treatment is almost useless.

Subacute Orchitis usually comes on with the same symptoms, though in a less marked form than in the acute variety. The swelling, however, is considerable, though of a softer kind. When the disease is chronic, the testis often becomes permanently enlarged and hardened, assuming an oval shape, being smooth, heavy, and uniformly expanded, with a sensation of weight, dragging, and severe pain, and a good deal of tenderness on pressure. This form of orchitis occasionally occurs in old people.

Orchitis may occur idiopathically, without any assignable cause in the way of external injury or local irritation in the urethra or prostate. This form of the disease is most common in middle-aged men, and more especially in those who are gouty. In fact the disease is in all probability one of the many local forms of gouty inflammation. It is not very acute but lingering, liable to recurrence, and to be followed either by hydrocele or chronic induration of the epididymis.

Atrophy of the Testis as a consequence of Inflammation is more liable to follow the orchitis of mumps in young men above the age of puberty than any other inflammatory affection of the organ. It is remarkable how rapid and how complete the wasting of the testis will be in these cases. A few weeks after the subsidence of the inflammation the testis will be found to be shrunk away, so as to form a small soft mass not larger than a filbert.

Atrophy of the testis may sometimes gradually ensue also as a result of chronic epididymitis, and the consequent induration of this structure. Strangulation of the vascular supply to the testis occurs, and the whole organ at last wastes so as to leave nothing but a small hardened mass in the scrotum.

Treatment.—The treatment of *Acutely Inflamed Testicle*, whether local or constitutional, is essentially antiphlogistic. The patient should be kept in bed with the testis raised on a small pillow between the thighs, and hot fomentations diligently applied. At the same time the swollen gland may be painted with an ointment composed of equal parts of glycerine and belladonna. This treatment will usually be found to give the patient most relief; but if the case be seen very early, before much swelling has taken place, the application of cold by means of Leiter's tubes (Vol. I., p. 204) or Otis's coil may sometimes cut the inflammation short and give immediate relief. Local blood-letting is often of great service when there is much pain. It is best carried out by puncturing the veins of the scrotum—a far better method than applying leeches, the bites of which are apt to become irritated. This little operation may be very effectually done by directing the patient to stand up, and to foment the scrotum for a few minutes with a hot sponge, so as to distend the veins; these may then be punctured at various points with a fine lancet, and the parts well fomented afterwards, so as to encourage the flow of blood. In this way six or eight ounces may be taken in the course of a few minutes; when enough has escaped, the further flow may be arrested by laying the patient down and elevating the part.

If there be much effusion into the tunica vaginalis, constituting acute hydrocele, relief may be afforded by puncturing this sac with the point of a lancet. Puncture of the testis itself, which has been recommended, is a needless and dangerous proceeding. I have known of a case in which it was followed by abscess in the gland, ending in its complete destruction.

The *Constitutional Treatment* during the acute stage consists in the administration of salines and antimony, with henbane in full doses, so as to give an aperient, a diaphoretic, and a sedative together; when this begins to act, great relief is usually afforded.

As the inflammation subsides, the treatment must be changed. When there is merely swelling and hardness left, with but little pain or tenderness, the testis may advantageously be strapped with adhesive plaster, so as to give good support and to promote absorption of plastic matter. Fricke of Hamburg has strongly recommended strapping in the acute stage; but I cannot say that I have ever seen any advantage derived from it at this period of the disease, though I have many times seen it tried; it has usually appeared to me to increase, sometimes very considerably, the pain in the part, and the general uneasiness.

In **Subacute Orchitis** much benefit is usually derived from a short course of Dover's powder and calomel, with early strapping of the testis. When the organ has become enlarged and indurated, as the result of chronic inflammation, it may be advantageously strapped either with simple plaster, or with one composed of equal parts of the emplastrum ammoniaci cum hydrargyro and soap-plaster; mercury in small doses, more especially the bichloride, being continued for some length of time, until the inflammatory products are absorbed and the hardness disappears.

In **Strapping a Testicle,** the scrotum should be shaved, and then drawn tightly upwards on the affected side. The Surgeon should next pass a long strip of plaster, an inch broad, above the enlarged testicle and round the corresponding side of the scrotum, so as to isolate it, as it were. Another strip is now passed from behind, in a longitudinal direction, over the lower end of the testis, and upwards upon the anterior part of the scrotum: and then, by a succession of horizontal and vertical strips, neatly overlapping and drawn tightly, the organ is completely enveloped and compressed. To be of any service, the strapping must be tightly and evenly applied; but at the same time care must be taken not to strangulate the scrotum by drawing down the upper strips of plaster too forcibly. In a case of syphilitic disease of the testis, in which I was obliged to have recourse to castration, the whole of the side of the scrotum had sloughed away, leaving the testis exposed and fungating, in consequence of the tight strapping which had been employed before the case came into my hands.

After the swelling has subsided, the patient must wear a suspensory bandage for some months.

The *Induration about the Epididymis,* which usually remains after epididymitis, must be treated by prolonged counter-irritation with tincture of iodine, or by the application of the iodide of lead or iodine ointment. So long as any induration is left, it is doubtful whether the secretion is able to find its way through the thickened epididymis.

Abscess, as the result of inflammation of the testis, is of rare occurrence. Sometimes the scrotum inflames at one point, where fluctuation becomes apparent, with thinned skin and evident signs of suppuration ; a puncture should here be made, and the pus let out as soon as formed. In true abscess of the testicle the pus forms under the tunica albuginea, adhesion takes place between the testis and the scrotum, the fibrous coat gives way, and the pus gets vent externally through the integuments. Into the aperture that necessarily results a portion of the secreting tissue of the gland sometimes projects, and, becoming inflamed, forms a red, granular, and fungous mass, protruding through and overlapping the edges of the aperture. The treatment of this condition will be considered when we come to speak of the scrofulous testicle.

Inflammation of the Testis in the Inguinal Canal may sometimes take place, even in adults, when the organ has not descended through the external ring ; giving rise to a train of somewhat puzzling symptoms which closely resemble those of strangulated incomplete hernia ; with which, however, it must be borne in mind that it may be associated (p. 851, Vol. II.). On examination, a large irregular tumour, in some parts hard, in others soft, very tender to the touch, and occasioning a sickening sensation when pressed upon, will be found in one of the groins, in the situation of the inguinal canal. There is usually a tendency to vomiting with some constipation, and colicky pains in the abdomen. On examining the scrotum, it will be found that the testis on the affected side is absent ; and, on passing the finger into the external ring, the organ can be felt to be lodged in the canal. In consequence of the proximity of the peritoneum to the inflamed testis, this membrane occasionally becomes involved in the morbid process ; and, as the result of the constriction of the tendinous and aponeurotic tissues in the situation, sloughing has occasionally occurred. Either of these conditions may lead to a fatal termination.

The *Treatment* should be actively antiphlogistic. Leeches must be freely applied over the part ; salines with antimony being at the same time administered, and fomentations diligently persevered in.

Inflammation and Abscess of the Cord.—In some cases the inflammation of the testis may extend, or the disease may, from the first, be limited to the areolar tissue of the cord, giving rise to tumefaction, with a good deal of pain and tenderness along it, and eventually abscess, accompanied by the usual signs of suppuration. The *Treatment* of such a case must be conducted on ordinary principles, early discharge for the pus being secured.

Chronic Orchitis of a persistent character constitutes a distinct disease of the testis, so closely allied to some forms of tumour of this organ in its character and pathology, that it will be more convenient to consider it with the Solid Enlargements of the Gland (p. 1222).

HYDROCELE AND HÆMATOCELE.

By **Hydrocele** is meant an accumulation of serous fluid, formed in connection with the testis or cord. Most frequently the fluid occupies the sac of the tunica vaginalis, constituting a true dropsy of it; in other instances, it appears to be formed in distinct cysts, situated either in connection with the testis, or upon the cord. Hence hydroceles are commonly divided into those that affect the *Tunica Vaginalis* and the *Encysted* variety.

Hydrocele of the Tunica Vaginalis, or **Vaginal Hydrocele,** may occur as the result of acute orchitis; the inflammation of the testis causing the effusion of a quantity of fluid into its serous investment (p. 1203). This, however, is not the kind of hydrocele that is commonly met with; the fluid so poured out as the result of active inflammation usually becoming absorbed as the parts recover their normal condition. The true or primary hydrocele occurs as a chronic disease, without any signs of inflammation of the testicle, or, at most, with but slight tenderness of that organ. It is most frequently met with in individuals about the middle period of life, commonly without any evident exciting cause, either constitutional or local. It is very common in men who have lived long in warm climates, and Sir J. Fayrer considers it in some cases to have a malarial origin.

In young infants, hydrocele is not unfrequently seen, and in them it may affect two forms: either the ordinary one, similar to that which occurs in adults in whom the tunica vaginalis constitutes a closed sac filled with fluid; or a less common variety, in which the accumulation of fluid in the tunica vaginalis communicates, by the persistence of a canal in the funicular prolongation of the peritoneum investing the cord, with the general cavity of that membrane. This form of hydrocele is *Congenital:* and the fluid in it occupies the same position that intestine does in a congenital hernia. It may readily be recognized by the fluid being made to flow back into the general peritoneal cavity, on raising or squeezing the tumour. But, although this may be considered to be the true congenital form of hydrocele in infants, the other variety of the disease also occurs in them when but a few days old, and very possibly even at the time of birth.

Symptoms.—The symptoms of hydrocele are tolerably evident. The disease begins with a degree of swelling and weight about the testis; the swelling may at first be soft, but after a while becomes hard and tense; or it may be so from the commencement. There is no impulse in it when the patient coughs. Whatever its original condition, the tumour soon becomes oval or pyriform in shape, being narrowed above, rounded and broad below; it is smooth and uniformly tense and hard; it usually fluctuates distinctly, but may have merely a semi-elastic feel. It reaches upwards along the cord, towards the external abdominal ring, which, however, is rarely invaded by it, and the cord is usually distinctly to be felt above the upper limit of the tumour. Most commonly the size varies from that of a goose's egg to a small cocoa-nut; but sometimes it may attain a considerably greater magnitude than this, and will then cause much inconvenience, as it reaches up close to the external ring, and drags over the penis, causing that organ to be buried in it, so as to interfere with micturition. Gibbon the historian had an enormous hydrocele, which was tapped by Cline, who drew off six quarts of fluid.

The most characteristic sign of hydrocele is its translucency. This may always be detected by the Surgeon grasping the posterior part of the tumour with one hand, so as to put the integuments of the fore part on the stretch, then placing the edge of the other hand along the most prominent part of the swelling, and having a lighted candle held close behind. If the walls of the sac be thick, or the fluid dark, the transmission of light through it may not be perceived unless the examination be conducted in a darkened room, or it may even become completely opaque. Another very simple and efficient method of determining the translucency is by putting the end of a stethoscope against the tumour, and looking down the tube against the light. It must not be forgotten that in infants a hernia may be translucent on account of the thinness of the structures at that age.

We have already seen that the ordinary hydrocele of the tunica vaginalis may vary as to size: it may also differ as to shape; in some cases being globular, in others constricted in the middle, or of an hour-glass shape (Fig. 988).

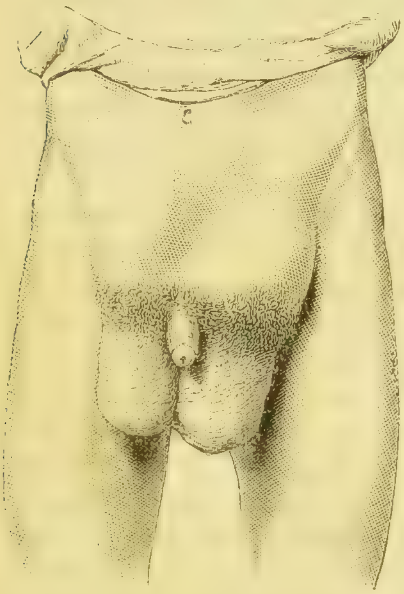


Fig. 988.—Double Hydrocele, extending through the external abdominal ring and simulating hernia.

The quantity of liquid varies considerably; there are usually from six to twelve or twenty ounces, but I have known a hydrocele to contain more than one hundred and twenty ounces. The fluid is generally clear and limpid, and of a straw colour. The specific gravity is from 1020 to 1024. It contains albumen in large quantities, but not quite equal in amount to that in pure blood serum. Fibrinogen is abundantly present, but the other constituents of fibrin are wanting, consequently the fluid is not spontaneously coagulable. Clotting can, however, be at once determined by the addition of a little blood serum containing white corpuscles. In very large and old hydroceles the fluid may become of a dark-brownish or chocolate hue, owing to the admixture of disintegrated blood: and it will then be found to contain flakes of cholesterine. The sac is usually thin; but in some old cases it becomes thick and dense, lined by a kind of false membrane, and divided by septa or bands, occasionally to such an extent as almost to separate it into distinct compartments. When the sac is thick, and the fluid opaque and turbid, there may be considerable difficulty in detecting the translucency.

The testis is often somewhat enlarged, especially about the epididymis, and frequently slightly tender, more particularly in the early stages of the complaint. It is almost invariably situated in the posterior part of the sac (Fig. 989), but may sometimes be found towards its anterior part. When this is the case, the epididymis will be found turned towards the front, owing to the organ being retroverted. If the hydrocele is of any size and tense, the testicle is lost in it. Its situation can then be recognized by the characteristic pain elicited by pressing on it, and by the opacity of the tumour at that point.

A peculiar form of hydrocele is occasionally met with which extends through the external abdominal ring forming a large tumour in the region of the inguinal canal, between which and the scrotal swelling fluctuation can be felt. There is in this form a distinct impulse on coughing. It occurs in those cases in which the processus vaginalis testis has been obliterated only at the internal abdominal ring, remaining patent below. Such cases are very rare and may resemble hernia, but they are easily distinguished by their translucency, their irreducibility, their absolute dulness on percussion, and their distinct fluctuation (Fig. 988).

The *Coverings* of a hydrocele are the same as those of the testis. Besides the integumental structures, aponeurotic prolongations from the intercolumnar and cremasteric fasciæ may be traced over the surface of the swelling (Fig. 990).

Treatment.—The treatment of hydrocele is divided into the *Palliative* and *Curative.* By the *Palliative* treatment the Surgeon seeks simply to relieve the patient of the annoyance induced by the bulk or weight of the tumour; but the *curative* has for its object the permanent removal of the disease.

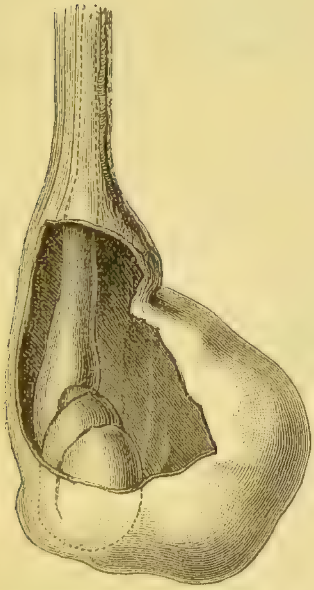


Fig. 989.—Hydrocele of the Tunica Vaginalis laid open.

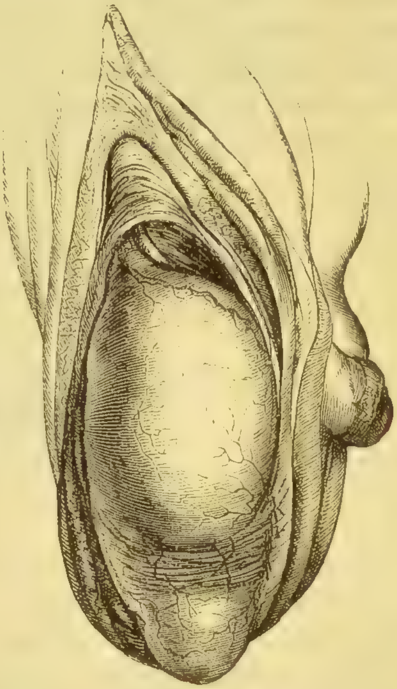


Fig. 990.—Dissection of a Hydrocele, showing its coverings.

The **Palliative Treatment** consists in the use of a suspensory bandage and cooling lotion, or in tapping with a fine trochar. These simple means, however, will sometimes succeed in effecting a radical cure. Thus, in infants, it will happen that the application of evaporating and discutient lotions may remove the effused fluid; and indeed it is seldom that any other plan of treatment than this is required in young children. The best lotion for the purpose consists of one composed of ʒj of chloride of ammonium, ℥j of spirits of wine, and ℥viij of water; with this the scrotum should be kept constantly wetted; and, if there be a communication with the peritoneum, a truss should be applied over the external ring. In adults it occasionally happens that simple tapping of the tumour has effected a radical cure. Many years ago a gentleman from Cuba consulted me for a small hydrocele which had been forming for several months; I tapped it with a fine trochar, and drew off about five ounces of fluid. This was followed by a radical cure. This case bears out a remark made by Brodie, that the few instances in which he had known simple tapping to produce a radical cure occurred in West Indians. I have, however, several times seen hydroceles disappear after having been tapped a few times, without any other treatment, in persons who had never been in hot climates. This simple operation is not, however, altogether free from danger; I have known an old man die from inflammatory œdema of the scrotum after having been tapped, and tetanus also has followed this operation. After tapping, it usually happens that the hydrocele slowly forms again, attaining its former bulk at the end of about three months. Occasionally it will be found that the hydrocele returns more and more slowly after each tapping; so that, by repeating this simple process at intervals of three, then six, then twelve months, the disease will finally disappear. This kind of progressive cure by simple tapping, I have several times seen, chiefly in old men. When a congenital hydrocele has been tapped, the sac soon fills again by drainage into it from the peritoneum; and, indeed, in such a case the fluid of an ascites has been drawn off by tapping the tunica vaginalis.

In tapping a hydrocele a few precautions are necessary, the principal being to avoid puncturing one of the scrotal veins, or injuring the testis. In the majority of cases the testis is situated at the back of the tumour, and is consequently altogether out of the way of the trochar. Its situation should, however, always be determined before the operation. This may be done by pressing with the finger firmly on different points of the sac in succession. The patient will usually be able at once to tell when the testicle is pressed upon by the peculiar "testicular sensation." The seat of the gland may be further determined by the want of translucency at the spot at which it is situated.

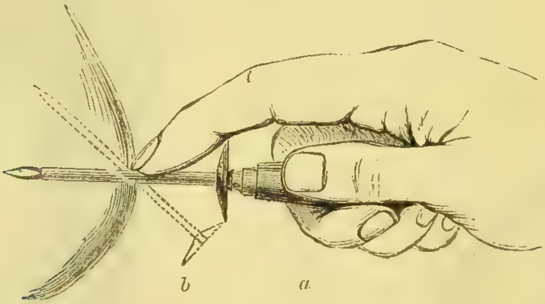


Fig. 991.—Tapping in Hydrocele: *a*, Introduction of Trochar: *b*, Position of Cannula.

The operation is then performed as follows:—1. The trochar should be well washed in carbolic acid lotion (1 in 20). 2. The patient should be made to lie down or sit on a chair, lest he become faint. 3. The Surgeon, then grasping the hydrocele, draws the scrotum back so as to make the coverings on the anterior part of the tumour as thin and smooth as possible. 4. He then selects a spot a little below the middle of the tumour where no blood-vessel is visible, and there taps the hydrocele. 5. The trochar must be held with its handle in the palm of the hand, and the index finger must be firmly pressed against the side about three quarters of an inch from its point to prevent its accidentally slipping in more deeply than is intended. It should not be thrust in with a sudden plunge—this is always painful and startling to the patient—but should be steadily pushed forwards, the tumour at the same time being pressed against its point. In this way the operation is almost painless, especially if care is taken to avoid blood-vessels and their accompanying nerves. The trochar is to be pushed in directly backwards (Fig. 991, *a*), but as soon as the stylet is withdrawn the cannula should be inclined obliquely upwards, so as to avoid the chance of pressure against the testis (Fig. 991, *b*). 6. When all the fluid has escaped, the cannula is slowly withdrawn, the edges of the small puncture pressed together and covered with a bit of plaster, or a little cotton-wool and collodion. A suspensory bandage should then be put on, and rest enforced for a few hours. The fluid sometimes escapes with a pulsatory movement, apparently communicated by the arteries of the cord. If the testicle have been found in front, the hydrocele should be tapped at the side or behind.

Before using the trochar, it is well to see that the cannula fits closely round the neck of the stylet; and, above all, that the instrument has not become rusty by having been carelessly put aside after use on a previous occasion, the cannula having been put while still wet on the trochar.

The **Curative Treatment** has for its object to restore the lost balance between secretion and absorption, but it is not necessary in all cases to obliterate the serous cavity by causing adhesions between the opposite sides. The means adopted for the cure of hydrocele are very various, but may be grouped in three classes :—1. The injection of irritating fluids into the cavity; 2. Drainage; and 3. Partial excision of the sac.

In order that the radical cure, in whichever way undertaken, should be safe and efficient, it is necessary, in the first instance, that the disease should have been allowed to attain a chronic condition, more particularly if the hydrocele have been of rapid growth. In order to prevent its attaining too large a size, it will be well to adopt palliative tapping once or twice before attempting the radical cure. Care must be taken to remove all inflammation and tenderness about the testis also, before having recourse to this means of treatment. If attention be not paid to this, recurrence of the hydrocele will probably ensue.

The treatment by **Injection** is that which is commonly employed. It consists in tapping the tumour in the usual way, and then throwing a sufficient quantity of stimulating fluid into the tunica vaginalis through the cannula, so as to excite a moderate degree of inflammation in it. Port-wine, or a solution of the sulphate of zinc of the strength of ʒi to ℥xij, was formerly employed, but their use has been entirely abandoned since the introduction of iodine for the purpose.

Injection of Iodine.—The injection of tincture of iodine, originally introduced by Sir J. R. Martin, whilst practising at Calcutta, is commonly regarded as a more certain and safer mode of treatment than any other. Many Surgeons prefer the liquor iodi to the tincture, believing it to be more certain in its effect. The quantity of tincture of iodine injected should vary from two drachms to half an ounce, according to the size of the tumour. It may be used pure or diluted with an equal quantity of water. After injection, the Surgeon should rub the scrotum gently over the testis, so as to diffuse the injection equally throughout the sac. One half the quantity thrown in should then be allowed to escape, the cannula removed, and the puncture closed with a piece of plaster. The cannula used for this purpose should be made of platinum and not of silver, which is apt to become corroded and made brittle by the action of the iodine. A good deal of inflammation, with fresh effusion into the sac, will generally be set up, usually accompanied by subacute inflammation of the testicle. This must be treated as an ordinary attack of orchitis (p. 1204). After the swelling has subsided a cure will usually be found to have take place.

Useful as the iodine-injection is, it sometimes fails in producing a radical cure of hydrocele. This is attributable to two causes : the first is, that in some cases sufficient inflammation is not set up to induce that condition of the tunica vaginalis which is necessary for a radical cure. It is well known that, when a hydrocele is radically cured by injection, it is so, not by any adhesion taking place between the two opposite surfaces of the tunica vaginalis and a consequent obliteration of its cavity, but by the inflammation that is artificially induced exciting such a modification of this membrane as to restore the balance between the secretion and absorption of the fluid by which it is naturally lubricated. Now, in some cases, sufficient inflammation is not induced by the introduction of the irritating fluid to restore the natural balance between these two functions of the membrane ; and the tunica vaginalis gradually fills again after the injection, as it would after the simple operation of tapping. It occasionally happens that the patient may suffer excruciating agony at the time of the injection, from the contact of the stimulating fluid with the surface of the testis, and yet little or no inflammation may be excited. The amount of suffering, therefore, at the time of the operation is by no means proportionate to the amount of inflammation which follows. Indeed, the reverse would appear to be the case in many instances ; and I have often observed that, in those cases which progress most steadily to a radical cure, there is but a moderate amount of pain at the time of the injection.

There is a second way in which injections would appear to fail : a considerable amount of inflammation is excited, and effusion takes place into the tunica vaginalis, which in the course of three or four days becomes distended to, or almost to, the same size, that it had previously to the operation ; but this effused fluid, instead of being absorbed by the end of the second or third week, remains unchanged in bulk, or absorption goes on to a certain point, and then seems to be arrested ; the tunica vaginalis remaining distended with a quantity of fluid.

A third way in which the failure arises, is in consequence of the walls of the sac being so thickened that they cannot collapse.

The proportion of cases in which the iodine-injection fails to bring about a radical cure of the hydrocele is variously estimated by different Surgeons. Thus Sir J. R. Martin states that in India the failures scarcely amount to 1 per cent. ; Velpeau calculates them at 3 per cent. I am not aware that any statistics of this mode of treatment in this country have been collected ; but the general opinion of Surgeons would appear to be decidedly in its favour, as being the safest plan of treatment that has yet been introduced. In this opinion I fully coincide : yet it is by no means improbable that the success of the iodine-injection in this country would prove to be not quite so great as is generally believed. I have seen a considerable number of cases of simple hydrocele of the tunica vaginalis, both in hospital and in private practice, in which a radical cure had not been effected, although recourse had been had to the iodine-injection by some of the most careful and skilful Surgeons of the day, as well as by myself. It is especially apt to fail in men advanced in years. In them there is either not sufficient inflammation excited, or if it be, the fluid that is as a consequence effused into the tunica vaginalis is not re-absorbed.

Injection of Pure Carbolic Acid, liquefied by the addition of 10 per cent. of glycerine, has been recommended by Levis of Philadelphia. He injects from 30 to 60 minims by means of a large hypodermic syringe, the needle of which can be used to draw off the fluid. The treatment seems to be very efficient and almost painless. In no recorded case has it caused carbolic acid poisoning or other inconvenience. Orchitis is said to be less common than after the use of iodine.

Drainage of the cavity may be carried out in various ways. If injection treatment failed it was the custom formerly to introduce a seton composed of silk threads. This at the same time that it drained the hydrocele most commonly set up a certain degree of inflammation in the sac commonly ending in suppuration. The pus was very apt to become septic and the seton openings being insufficient for the exit of the discharges dangerous inflammation of the sac and scrotum not uncommonly followed. For these reasons the use of the seton has been altogether abandoned. Its place has been taken by various methods of antiseptic drainage. The simplest of these is the introduction of a good sized india-rubber drainage-tube, with the application of an efficient antiseptic dressing. This, however, was found frequently to fail to effect a radical cure, the sac refilling after the tube was removed. *Free incision* was, therefore, recommended by Volkmann. In his operation the sac is incised along its anterior aspect and the fluid evacuated and the cavity washed out with carbolic acid lotion (1 in 20) ; the tunica vaginalis is then attached to the skin by a few points of suture and the parts dressed antiseptically. The operation is not followed by orchitis and the wound heals in about two weeks. The results have been very satisfactory, but relapses have occurred even after this. Von Bergmann, therefore, in order to prevent any possibility of recurrence, recommended **Excision of the Tunica Vaginalis** as completely as possible, a proceeding which, in his hands, seems to have been followed by no unpleasant consequences. Kocher and Juillard, however, advise that the whole sac should not be removed. They expose the tunica vaginalis and separate it from the superficial coverings of the testicle, great care being taken not to injure the vas deferens or vessels which may be spread out on the sac. All bleeding being arrested the sac is opened and as much cut away as will leave a sufficient covering for the testicle. The edges of the sac are then united by catgut sutures and finally the wound in the skin is united in the same way. Kocher recommends no drainage. Juillard drains the external wound. If all goes well no inflammation of the testicle or the sac follows and the patient is well in eight days.

In hydrocele of children and infants **Acupuncture** will often be found to effect a cure. The scrotum having been put upon the stretch, the hydrocele is punctured at two or three points with a large darning-needle, introduced slowly by being rotated between the finger and thumb. From the punctures thus made the serum slowly escapes into the cellular tissue of the scrotum, whence in two or three days it is absorbed.

This mode of treatment will be found also the safest and most effectual in the hydroceles of young children in whom it would be extremely dangerous to attempt a cure by injection of iodine. It may always be safely employed if the application of the lotion before mentioned fails to cure the disease.

It is not always prudent to have recourse to the radical cure in the treatment of hydrocele. In persons advanced in years, or of feeble and unhealthy constitution, the inflammation excited in the tunica vaginalis by any of the means just detailed may run on to such an extent as to give rise to inflammatory œdema, and even sloughing of the scrotum, with great danger to life. In these subjects it is much safer and usually sufficient to temporize with the hydrocele, and only to tap as occasion arises from the increasing size of the swelling.

Encysted Hydrocele.—In this variety of the disease the fluid does not lie in the tunica vaginalis, but is contained in a cyst which projects from the surface of the epididymis or testis, and pushes the serous investment of the gland before it.

These cysts are much more frequently found connected with the epididymis than with the body of the testicle. Indeed, Curling has pointed out the fact, that small pedunculated cysts about the size of currants, and composed of a fine serous membrane, lined with tesselated epithelium, are very frequently found beneath the visceral tunica vaginalis covering the epididymis. They are delicate in structure, contain a clear limpid fluid, and are very liable to rupture. They are met with at all ages after puberty. According to Gosselin, after the age of forty, they occurred in at least two-thirds of the testes examined to ascertain their presence. Such cysts as these may remain stationary, of small size, undiscernable during life; they may rupture into the tunica vaginalis; or they may enlarge and become developed into tumours of considerable magnitude.

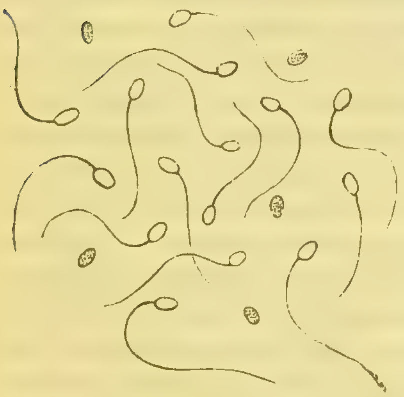


Fig. 992. — Spermatozoa from Encysted Hydrocele.

The fluid of these cysts possesses the remarkable characteristic, discovered by Liston, of containing spermatozoa (Fig. 992). Though spermatozoa do not always exist in this fluid, yet they are usually met with, sometimes in small quantities, at others so abundantly as to give it a turbid or opalescent appearance. This admixture of spermatozoa with the clear fluid of the cyst is probably due, as pointed out by Curling, to the accidental rupture of a seminal duct into an already existing cyst. Spermatozoa have also, but very rarely, been found in the fluid of an ordinary hydrocele of the tunica vaginalis; and then probably their presence was due to the rupture of one of these cysts into the tunica vaginalis. Hence their presence in the fluid of hydrocele may in most cases be considered as characteristic of the encysted variety of the disease.

The *Signs* of encysted hydrocele differ in some respects from those presented by hydrocele of the tunica vaginalis. The tumour is smaller, more irregular in shape, and does not envelop the testis completely, but is situated behind and above it, rather in connection with the epididymis.

The *Diagnosis* from ordinary hydrocele of the tunica vaginalis may be made by observing: 1. That the testis is below and in front, and not covered in by the encysted form of the disease; 2. That the tumour is more globular or irregular, and less pyriform; 3. When tapped, the fluid will usually be found to be opalescent.

The *Treatment* consists in injecting the sac with tincture of iodine, or in incising the tumour and allowing it to granulate from the bottom. The injection by iodine is not so frequently successful in this as in the last variety of the disease, but deserves a trial; if it fail, incision of the tumour will always effect a cure. In encysted hydrocele, the iodine injection should not be so strong as that which is used for injecting the tunica vaginalis. It should be diluted with two or three parts of water, as it comes more directly into relation with the structure of the testis.

Hydrocele of the Cord.—This disease is characterized by the presence of a round or oval tumour, situated on the cord, below or within the inguinal canal. It is smooth, elastic, and, if of sufficient size, may show semi-transparency on examination by transmitted light. It can be pushed up into the abdomen, unless the testicle be drawn firmly down so as to put the cord on the stretch, when the cyst becomes fixed. It receives no impulse on coughing, and does not alter in size on being steadily compressed. Occasionally more than one cyst may be met with. It appears to be due, in some cases, to imperfect closure at one or more points of the funicular portion of the tunica vaginalis, and to distension by fluid of the unclosed portions; though it is possible that in other instances it may arise as a distinct cystic growth, possibly from the remains of the Wolfian body or organ of Giraldés. These tumours may occur at all ages, but are met with chiefly in the young, and are not unfrequent amongst children. The fluid of a hydrocele of the cord is lighter in colour than that of one of the tunica vaginalis.

The *Treatment* of these cysts is best conducted by dissecting them out. If simply punctured they speedily fill again; injection of iodine is uncertain and may give rise to troublesome inflammation, and the seton is very likely to lead to diffuse suppuration. In dissecting them out care must be taken not to injure the constituents of the cord. If they rupture, and the whole wall cannot be got away, recurrence is very likely to occur.

Diffused Hydrocele of the Spermatic Cord consists in the infiltration of the cord with serous fluid, contained in rather distinct spaces, and giving rise to an oval or oblong irregular circumscribed tumour, extending below and into the inguinal canal. The *Treatment* consists in the application of blisters, or of counter-irritant plasters. Should the disease prove very troublesome, an incision might be made down to and into the swelling, so as to let out the fluid and allow the cyst to become consolidated.

Hæmatocele.—By *Hæmatocele* is meant an accumulation of blood in the tunica vaginalis, distending that sac, and compressing the testis. It is of two kinds, *Traumatic* and *Spontaneous*. The *Traumatic* is the most common form, usually arising from a blow on or a squeeze of the testis, by which one of the veins ramifying on the surface of the gland is ruptured, and blood is poured into the tunica vaginalis. It may arise also in tapping a hydrocele, from the point of the trochar being pushed too directly backwards and puncturing the testis, or wounding a vessel in the cord, or occasionally from a blow upon a hydrocele. *Spontaneous Hæmatocele* is a disease of rare occurrence, arising apparently from the rupture of an enlarged spermatic vein into the tunica vaginalis. It attains a larger size, and is altogether a more formidable affection, than the traumatic hæmatocele.

Characters.—In whatever way occurring, a hæmatocele slowly but gradually increases until it attains about the size of a duck's egg, or even that of a cocoa-nut. It is seldom that it becomes larger than this; but cases are recorded in which the tumour has attained an enormous magnitude. I once operated in a case in which a spontaneous hæmatocele had existed for six years; it was as large as a good-sized melon, and contained, besides about a quart of dark thin blood, a handful of partially decolorized and tough fibrin, the greater portion of which was firmly adherent to the inside of the greatly thickened tunica vaginalis in filamentary and laminated masses, with here and there nodules interspersed. The whole of the interior of the tunica vaginalis closely resembled an aneurismal sac.

The fluid contained in the hæmatocele, when the disease is recent, consists of pure blood. The blood so effused will continue fluid for years; but at last it may decompose and set up fatal inflammatory mischief; in some rare instances the tumour becomes partly solidified by the deposit of masses of fibrinous coagulum lining the interior of the tunica vaginalis, which are sometimes decolorized and arranged, as in the case just referred to and in one recorded by Bowman, in a laminated manner, like the contents of an aneurismal sac. When the hæmatocele is of old standing, changes take place both in the effused blood and in the sac. The blood in old hæmatoceles becomes at first dark and treacly. As chemical changes advance further it becomes converted into a dirty-brownish fluid, full of shreds of partly decolorized fibrin and crystals of cholesterine. The tunica vaginalis becomes thickened and indurated, and in exceptional cases may undergo calcification. This change I found in a patient whose disorganized testis I removed for a hæmatocele of nearly forty years' standing.

Symptoms.—These are generally sufficiently obvious. The occurrence of the tumour subsequently to a blow, strain, or injury when traumatic, its gradual increase in size, its somewhat heavy but semi-elastic or obscurely fluctuating feel, and the absence of translucency, form the most important signs. Its shape is somewhat uncertain. When recent it may have the pyriform shape of a hydrocele, but an old hæmatocele is always more or less oval or rounded in form and smooth on the surface, and thus comes closely to resemble a solid tumour. Except in very old cases, in which atrophy of the testicle from pressure has occurred, the peculiar "testicular sensation" will be perceived by the patient if the site of the gland is pressed upon.

Diagnosis.—Hæmatocele may be mistaken for hydrocele, hernia, and other scrotal swellings. The mode of distinguishing it will be described at the end of this chapter, with the diagnosis of scrotal tumours in general. It is most frequently confounded with solid tumours of the testicle; and upon this fact is founded the excellent rule of practice never to remove a doubtful tumour of the testis without first ascertaining, by an incision into its substance, that it is not a hæmatocele.

Treatment.—This must vary with the size and duration of the tumour. When it is small and recent, and has fluid contents, the Surgeon may try the effect of tapping it; it is possible that, after the evacuation of the blood, closure and obliteration of the tunica vaginalis will take place. This happened in a case under my care, in which, though the disease had existed for three years, a complete cure followed the operation of tapping. Such simple treatment as this, however, cannot be depended upon; and it usually becomes necessary to lay the sac open, treat the wound antiseptically, and to cause it to contract and to granulate from the bottom, when the obliteration of the cavity of the tunica vaginalis necessarily results. If the tumour were of very large size, and the tunica vaginalis much thickened, hardened, and parchment-like, with adherent and laminated fibrin, castration might possibly be required. In the instance to which I have already referred, and which is represented in Fig. 993, this was rendered necessary in consequence of these conditions, and was successfully done.

Hæmatocele of the Spermatic Cord has been observed by Pott, Curling, Bowman, and others; it is a rare disease, and usually occurs in the form of a tumour of considerable magnitude, suddenly arising after a strain or some violent exertion, giving rise to rupture of a varicose spermatic vein. It commences in the inguinal canal, and thence extends downwards along the course of the cord, through the abdominal ring into the scrotum; but it does not surround or implicate the testis, which can be felt free and movable at its lowest part. On incising such a tumour as this, a quantity of blood, partly fluid and partly coagulated, has been found, sometimes contained in a cavity occasioned by the laceration and separation of the tissues of the cord and scrotum. The most remarkable case of this kind on record is one related by Bowman, in which the tumour, after existing for ten years, had attained so enormous a size, that it reached to the patella, and was so heavy as to require both hands and a considerable effort to raise it from its bed. In this case, death appears to have resulted from decomposition of the contents of the tumour.

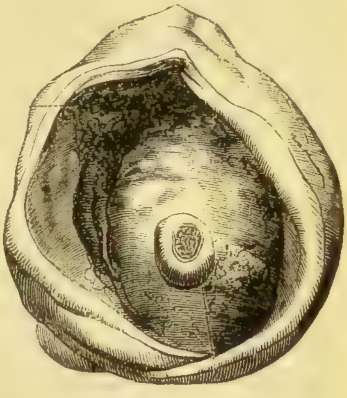


Fig. 993.—Hæmatocele with thickened Tunica Vaginalis and adherent Fibrin.

Diagnosis.—In its early stages, hæmatocele of the cord would run considerable risk of being confounded with an *inguinal hernia.* The more diffused character of the swelling, however, its regular feel, its semi-fluctuating sensation, and the impossibility of reduction, might enable the diagnosis to be made (p. 842, Vol. II.). Hæmatocele of the cord may always be distinguished from an accumulation of *blood in the tunica vaginalis,* by the testicle not being implicated in the former case, but surrounded by the fluid in the latter.

The **Treatment** of this disease must in the earlier stages be of a palliative kind; consisting in rest, support of the tumour, and the application of evaporating lotions. Care should be taken not to incise it at this period, lest the loss of blood from the ruptured vein, after the evacuation of the contents of the tumour, become uncontrollable. In one instance I have known fatal consequences from this cause ensue in half an hour after making an incision into the tumour and turning out the coagula. When, however, the disease has reached a chronic stage, and is no longer increasing, it may be incised; and its contents being turned out, the cavity may be allowed to granulate.

VARICOCELE

Varix, or Enlargement of the Spermatic Veins, is a disease that is commonly met with from the age of puberty to about the thirtieth year, seldom commencing later than this. It usually occurs in feeble individuals having the scrotum lax and pendulous ; and in some cases appears to have been brought on by venereal excesses. The spermatic veins, extending as they do from opposite the lumbar vertebræ to the plexus pampiniformis, which constitutes the base of the pyramidal tumour formed by a fully developed varicocele, are necessarily subject to considerable tension from the weight of so long a column of blood as that contained within them, to which they may yield, becoming much dilated and tortuous. The left spermatic vein is far more frequently affected than the right ; owing probably to its compression by feculent accumulations in the sigmoid flexure of the colon. The theory that there is an obstacle at its mouth, occasioned by its pouring its contents into the left renal vein, at right angles to the current of blood flowing through that vessel into the vena cava is probably altogether erroneous. The right spermatic veins are rarely affected ; and never, I believe, without those on the left side participating in the disease. In these cases of double varicocele, the left is almost invariably the more seriously affected ; but I have seen exceptions to this in one or two instances, in which the veins on the right side formed the larger tumour.

Symptoms.—The symptoms of varicocele consist of a tumour of pyramidal shape, having a soft knotted or knobbed feel, owing to the irregularly swollen and convoluted condition of the veins, with its base upon the testis and the apex stretching up to the external ring. The swelling increases when the patient stands up, if he take a deep inspiration, cough, or make any violent exertion. Its size varies from slight fulness of the veins to a large mass, several inches in circumference at the base. When the patient lies down, it goes up to a certain extent, but immediately returns to its former magnitude when he stands up. It is attended by a sensation of weight and sometimes of pain, which is occasionally very acute, of a severe and neuralgic character, even in the scrotum, the groins, and the loins, more particularly when the tumour is unsupported. This pain is greatly increased on the patient walking or riding ; so much so, that in some cases he is almost debarred from taking necessary exercise, and is prevented from following any active occupation. Debility of the generative organs, with a tendency to seminal emissions and much mental depression, frequently accompanies varicocele. Atrophy of the testicle is sometimes found associated with varicocele, and is believed to be dependent upon it. Rupture of one of the dilated veins may occur from external injury, giving rise to an enormous extravasation of blood into the areolar tissue of the scrotum. Of this Pott relates a case. I have known the accident to be attended with fatal consequences. A man who, to use his own expression, "had been romping with his wife," received a blow on a varicocele, when an enormous extravasation of blood rapidly formed in the scrotum and the cord, for which he was admitted into the Hospital. The tumour was incised, and large masses of coagula were turned out. The patient shortly after, in the absence of assistance, suddenly became faint and died of venous hæmorrhage. The bleeding was found to have proceeded from a ruptured spermatic vein.

Diagnosis.—The diagnosis of varicocele is always sufficiently easy; its peculiar convoluted feel, its broad base and narrow apex, the manner in which it goes up when the patient lies down, and returns again when he stands up, are sufficient to distinguish it from all other scrotal tumours. From *inguinal hernia* the disease may be distinguished by attention to the test described at p. 843, Vol. II.

Treatment.—The treatment of varicocele must be conducted with reference to the severity of the symptoms occasioned by it, and to the extent of the disease. When, as is usually the case, it gives rise to but slight inconvenience, palliative treatment is fully sufficient; but if, as occasionally happens, the disease be a source of very intense suffering, or tend to the induction of atrophy of the testis, or to generative debility, with much mental disquietude or hypochondriasis, then the Surgeon may feel disposed to endeavour to cure the varicocele radically.

The **Palliative Treatment** of varicocele resolves itself into means of various kinds, having for their object the support of the testis and the diminution of the length, and of the consequent pressure, of the column of blood. This is usually most conveniently done by supporting the scrotum in a well-made suspensory bandage; or pressure may be made upon the part, as well as support given, by enclosing the testis in an elastic bag. In other cases, support may be afforded by drawing the lower portion of the scrotum on the affected side through a ring made of soft metal, covered with leather, or better still, through a small vulcanized india-rubber ring, so as to shorten the cord. And, with the same object, excision of the lower portion of the scrotum has been recommended; so that, by the contraction of the cicatrix, the testis may be pressed up against the ring, and the cord thus shortened. This plan, however, is somewhat severe; and though it might be attended by temporary benefit, the advantage accruing is not likely to be very continuous. The pressure of the pad of a truss on the spermatic cord, as it issues from the external ring, will break the length of the column of blood in its veins, and might thus be of service. But many patients cannot bear the irksome pressure of the instrument; moreover, it must be remembered that it will at the same time obstruct the return of blood, and consequently in all probability do as much harm as good. In addition to these mechanical means, the part may be braced by cold douching, sea-bathing, and the general strength improved by the administration of iron.

The **Radical Cure of Varicocele** consists in the obliteration of the enlarged veins, on the same principle that guides us in the management of varix in other situations.

The circumstances for which operation may be and has been practised in this disease can be arranged in the following categories:—

1. When the existence of a varicocele disqualifies the sufferer from admission into the public services, there is, in my opinion, a perfectly legitimate reason for operating. One of the cases in which I have effected a radical cure was that of a man in the prime of life, who, wishing to enlist in the Marines, was refused solely on the ground of having a small varicocele. This I cured by operation, and the man afterwards entered the service.

2. In some cases, the presence of a varicocele of inordinate size causes a distressing sense of weight and pain in the loins and groins, and often inability to stand or walk for any length of time. Here, when the patient is

in continual discomfort, or more or less prevented from pursuing his ordinary avocations, it is perfectly justifiable to resort to operation.

3. When atrophy of the testicle is a consequence of the pressure of the blood in the veins, an operation may be performed.

4. Cases not uncommonly occur where the pressure of the enlarged veins on the spermatic nerve produces repeated attacks of spermatorrhœa. These cases are, however, more frequently met with out of hospitals, than in individuals of the class who apply to such institutions for relief. In fact, young men of the more highly educated classes are very subject to varicocele, especially those who habitually lead a sedentary and studious life, as, for instance, young clergymen and lawyers. In these persons a peculiarly hypochondriacal state is brought on by the tendency of the mind to dwell on the condition of the genital organs, and the patient is constantly fidgeting about the local and tangible disease he observes in them.

The radical cure of this condition may be produced by exciting inflammatory thrombosis of the spermatic veins, through an application of the same principle which sets up that process in the veins of the lower extremity. There are several different ways of doing this ; but some are very objectionable. The twisted suture, as applied to the veins of the leg, induces too great irritation in the scrotum, and there its introduction is often followed by violent inflammation or sloughing, or by an opening up of the areolar tissue of the scrotum with œdema, and even purulent infiltration. It is better, I think, not to use this method here ; indeed I have twice, in the practice of others, seen it followed by death. The plan I adopted for many years is that suggested by Vidal de Cassis, and is as follows. The vas deferens, readily distinguished by its round cord-like feel, is first separated from the veins, and entrusted to an assistant ; next, an iron pin bored with a hole at each end (Fig. 994), is passed between the vas and the veins, and brought out at the point of perforation, the scrotum being first notched with a scalpel ; then a silver wire, threaded on a needle so constructed that the wire shall follow it without catching (Fig. 995), is passed in at the aperture of entry of the pin, and carried between the integument of the scrotum and the veins, the wire being brought out at the second puncture (Fig. 996). Each end of the wire is now passed through the corresponding hole of the pin, which is twisted round and round repeatedly, each turn causing the wire to be rolled around the pin, and so tightened, till the veins are firmly compressed between the pin behind and the loop of wire in front (Fig. 997). By this means the scrotum is quite free and uncompressed, and there is no danger of exciting inflammation or œdema. The wire should be tightened from day to day, as it causes ulceration in the veins, until it has completely cut through, which results, usually, in about a week or ten days. Meanwhile, there is much inflam-

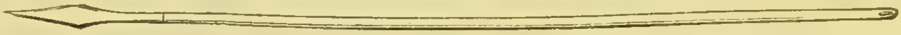


Fig. 994.—Iron Pin for Treatment of Varicocele.

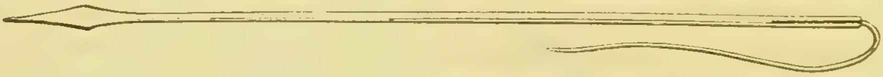


Fig. 995.—Split Needle threaded with Silver Wire.

mation around the veins ; this finally contracts and obliterates their channels. This method produces an effectual and permanent cure (Fig. 998).

Of late, I have been in the habit of employing a simpler method. I separate the vas deferens in the usual way, and then make a small incision, about half an inch long, in the front and back of the scrotum ; afterwards I pass a needle armed with silver wire, as before described, between the vas and the veins, bringing it out behind ; I then return the needle, but this time carrying it in front, between the veins and the skin ; and thus the veins are included in a loop of wire, without implicating the scrotum. The loop is then tightly twisted together, so as to constrict the enclosed vessels. This plan has a similar effect to that of the wire and pin combined ; by repeated tightenings the wire gradually effects a passage by ulceration through the veins, which are obliterated by the same process.

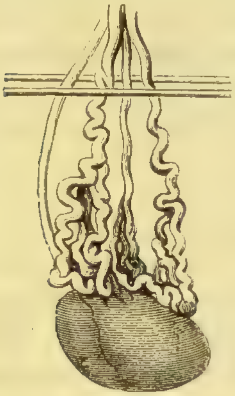


Fig. 996.—Vidal's Operation for Varicocele : Needles and Wire applied.

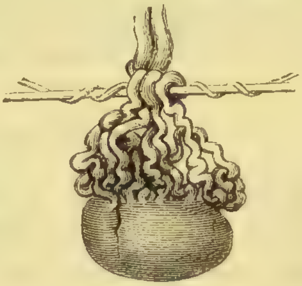


Fig. 997.—Wire twisted and Veins rolled up.

Fig. 998.—Vidal's Operation : Appearance of Needle and Wire when removed.

It has been objected to this and similar operations, that atrophy of the testis may take place, from the spermatic artery being included together with the veins. Experience shows that there is no risk of this. Even if the spermatic artery were obliterated, the artery of the vas deferens, the cremasteric, and other branches, would enlarge and take its place. In most cases, however, it probably escapes, being held out of the way with the vas deferens, but observations on the dead body show that this does not always occur.

Since the introduction of the antiseptic treatment of wounds the risk of pyæmia following ligature of a vein is so completely abolished that the operation of exposing the enlarged veins and tying them may be safely undertaken. It is thus performed. A small incision, one inch in length, is made over the spermatic cord, commencing about one inch below the external abdominal ring. The skin and superficial fascia are then dissected carefully through, until the cord is exposed. An assistant then grasps the cord immediately above and below the incision, and squeezes it forwards till it projects from the wound. The veins are then isolated, and a double ligature of carbolized catgut or silk is passed under each by means of an aneurism-needle. The veins are then divided between the ligatures, which are cut short, and dropped into the wound. If the incision is made high enough up, two or three veins at most will require ligature. The wound is then closed by a single stitch, and an absorbent antiseptic dressing is applied. No drainage is required in ordinary cases, and the dressing may be left unchanged for a week, at the end of which time the small wound will usually be found to have united by the first intention. The operation has the great advantage of causing no pain during the after-treatment, and it is certainly as safe as any other. It has been performed in a large number of cases in University College Hospital with the best results. Pearce Gould has also operated successfully on a considerable number of cases, by dividing the veins with a galvanic cautery, the wire being passed round them from a small puncture in the skin.

SOLID ENLARGEMENTS OF THE TESTIS.

All solid enlargements of the testicle were formerly classed together under the generic term of **Sarcocele;** and when they were conjoined with fluid accumulations in the tunica vaginalis, they were termed **Hydro-sarcocele.** The term is of little use; but so long as it is understood that it means no more than a solid enlargement of the testicle, there is no harm in using it. Solid enlargements of the testicle may be divided into the *Simple*, the *Syphilitic*, the *Tubercular*, and the true *Tumours of the Testicle.*

Chronic Orchitis or **Simple Sarcocele** is a chronic enlargement of the testis resulting from inflammatory mischief in the organ not arising from syphilis or tubercle. Such cases are undoubtedly rare. Our increased knowledge of both tubercle and syphilis has taught us that the great majority of cases formerly classed as simple sarcocele are really due to one of these two causes. Still, excluding all such cases, a residue is left to which the name of simple orchitis may be applied.

Causes.—Chronic orchitis may be a consequence of acute inflammation from any cause. It also arises from blows or squeezes in old people. Most commonly it is associated with some disease of the urinary organs, such as stricture or chronic enlargement of the prostate. In other cases it may be associated with rheumatism or gout.

Symptoms.—The testicle feels hard, smooth, solid, though perhaps slightly elastic at points; it is ovoid in shape, and usually about as large as a duck's egg. It is heavy and but slightly painful, and, except in very old cases, the peculiar sensation felt on squeezing a testicle is present. The cord is usually somewhat thickened, and, as well as the groin, is the seat of pain of a dragging character. The tunica vaginalis occasionally contains serous fluid lying in front of and obscuring the testis. The scrotum is always healthy, and almost invariably one testicle only is affected.

Occasionally simple chronic inflammation may terminate in suppuration, giving rise to **abscess of the testicle.** In these circumstances, a part of the indurated testicle softens and becomes prominent, the skin becomes red, shining and thinned, and adhesions form between it and the gland beneath. At last the abscess bursts, and through the aperture a fungus (**hernia testis,** or **benign fungus of the testicle**) speedily protrudes, which grows sometimes slowly, sometimes rapidly, perhaps attaining a very considerable size (Fig. 998). As the fungus increases, the organ appears to atrophy, but in reality is pressed out of the scrotum and merges into the fungus. This fungus is not a new growth, but is composed of the tubuli testis and inflammatory products. It is in the form of a pale-reddish yellow granular mass. If small and firm, it may become a very chronic complaint ; but if large, rapidly growing, and loose-textured, it speedily destroys the secreting structure of the testis, leaving nothing but a thickened epididymis and a contracted and shrunken tunica albuginea. It is, however, surprising how long the functions of this organ will continue, though its tissue is in a great measure destroyed, and its structure traversed by suppurating fistulæ. In other cases no fungus appears, but a fistulous track may be left, leading to an imperfectly drained cavity surrounded by indurated tissue, and this may remain unhealed for months or even years. Occasionally, instead of bursting and giving rise to fungus, the abscess may become surrounded by dense fibroid tissue and remain stationary, and this dense wall has been known to calcify.

Structure.—On making a section of a testicle affected with simple chronic inflammation, the tunica vaginalis will be found to be more or less adherent, and perhaps separated from the tunica albuginea in parts by small collections of fluid. The tunica albuginea is thickened, often presenting on its external surface a series of firm, glistening layers. The septa of the testis are seen to be thickened, rendering the whole organ hard and firm, and giving it a bluish-grey appearance. The microscope shows that the chronic inflammation chiefly affects the intertubular fibrous tissue, but in many cases this is accompanied by catarrhal overgrowth of the epithelium.

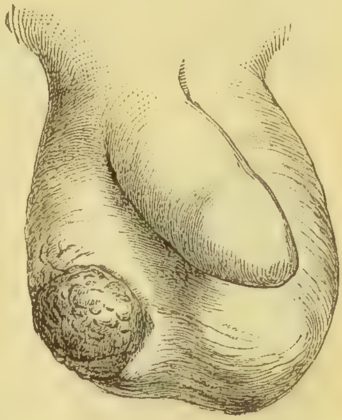


Fig. 999.—Hernia Testis.

Prognosis.—Simple chronic orchitis usually terminates in recovery, but the organ may be left somewhat enlarged and indurated, or in other cases it may undergo atrophy as the inflammatory products become absorbed.

Treatment.—Strapping and the administration of an alterative course of perchloride of mercury may be tried. If the organ do not diminish in size by these means, or if it be a source of much inconvenience to the patient, it must be removed. If accompanied by hydrocele the tunica vaginalis must be tapped, but on no account should injection of iodine be resorted to. If abscesses form, they must be opened. When a fungus has protruded, means must be taken to repress or remove this, lest it go on to complete destruction of the testis. If it be of small size, the best plan will be to sprinkle it with iodoform, and to strap it tightly down with a piece of lint and strapping. If it be larger, it may be shaved off, and the cut surface then dressed with some antiseptic application ; care being taken during cicatrization to repress the granulations below the level of the surrounding integument by strapping and pressure. Syme recommended that the pressure should be effected by the integument of the part ; an elliptical incision being made round the fungus and the edges of the opening in the skin through which it protrudes pared away, the scrotal integuments are freely separated by dissection from their subjacent connexions, and brought together over the protruding mass and secured by sutures. This operation I have practised with success. Should the fungus be of very large size, so as to include within itself the whole or greater part of the structure of the testis, it may not be possible to save any of that organ; and in these circumstances it is better to remove the whole gland; if left it could never be of any service, and would continue slowly to suppurate.

Tubercular Testicle, Scrofulous Testicle, or Tubercular Sarcocele.—This disease, although occasionally met with in individuals apparently strong and healthy, usually occurs in those of a feeble or cachectic constitution, most frequently in early manhood, but occasionally in advanced life or childhood, and, although often associated with phthisis, may occur without any evidence of tubercle in other organs. It is very common to find both glands affected, but the disease is usually more advanced in one than in the other. In some cases it arises apparently as a sequence of gonorrhœal epididymitis, or there may be a history of some injury to the testicle. The disease almost invariably commences in the epididymis, either at the globus major or minor, which becomes swollen, indurated, and slightly tender. As it progresses, it spreads upwards along the vas deferens until it may reach the prostate and vesiculæ seminales, and forwards through the corpus Highmori into the body of the testis. In some rare cases, it is said to commence in the body of the gland. The progress of the disease is usually slow, but it may go on rapidly to almost complete destruction of the testis. In a well-marked case the following conditions will be found. The testicle is moderately enlarged, but on examination this enlargement will be found to be chiefly in the epididymis, which can be felt as an irregular, craggy, nodulated mass, half surrounding the body of the gland in the form of a crescent situated at its posterior aspect (Fig. 1000). In the hard mass, which often considerably exceeds the body of the gland in bulk, spots of softening may be felt. The gland itself may seem soft and natural, or a nodule or two may be felt in its substance. The affection is not as a rule complicated by hydrocele, and in the earlier stages the scrotum is unaffected. The spermatic cord will usually present no general thickening, but the vas deferens is enlarged. Instead of feeling like a piece of whipcord between the fingers it may be as large as a quill. If the disease have extended to the vesiculæ seminales, these can be felt enlarged and hardened by introducing the finger into the rectum. There is little or no pain, and on squeezing the gland the ordinary sensations will be perceived by the patient except in a very advanced stage of the disease. As the disease advances, one of the craggy nodules softens, and the skin becomes adherent over it. This process is accompanied by more acute inflammation, usually causing marked increase of pain and tenderness. The adherent skin becomes red and shining, and finally gives way, and the tuberculous abscess discharges, leaving an unhealthy cavity yielding thin pus mixed with soft, shreddy, whitish-yellow sloughs. In some favourable cases the cavity may granulate and close completely, or leave merely a fistulous opening discharging small quantities of serous fluid. In most cases, how-

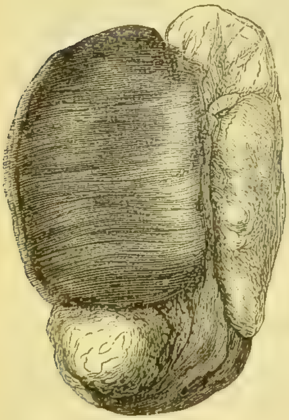


Fig. 1000.—Tubercular Testicle, showing the diseased Epididymis forming a crescentic mass partially surrounding the healthy body.

ever, the process of softening extends, other nodules break down, and a great part of the testicle may be destroyed. If an abscess should form in the body of the gland, a hernia or fungus testis may follow, as in simple chronic orchitis. Occasionally exuberant granulations may sprout out from the region of the epididymis, closely resembling the true fungus testis. The general health suffers greatly, and in a large proportion of cases tubercular disease of the lungs makes its appearance. Most commonly the opposite testicle also becomes affected. Death usually results from the disease of the lungs, but may occur from acute general tuberculosis with tubercular meningitis. Occasionally the disease may extend to the urinary tract, and terminate fatally from tubercular disease of the kidneys. In other cases the disease of the testis may occur after that of the kidney and prostate, forming merely a part of general genito-urinary tuberculosis.

In some cases of phthisis, in which the testicles enlarge, and yet give but little trouble, the whole organ, both body and epididymis, may be found converted into a uniform soft cheesy mass. A specimen of two such testicles, from a patient who died from disease of the lungs, is in the museum of University College. In cases of acute general tuberculosis, grey granulations have been found in the testicles.

Structure.—On making a section from before backwards through a typical specimen of tubercular disease of the testicle, the following conditions will be found. The tunica vaginalis may be perfectly healthy, or may be here and there adherent to the tunica albuginea. The tunica albuginea will be normal in appearance, except in the immediate neighbourhood of a tubercular growth, where it will be thickened. That part of the body of the gland nearest the surface may be perfectly healthy in appearance; there is no thickening of the septa, and the tubules can be teased out under water as in a healthy testicle. As we approach the corpus Highmori, the gland becomes studded with small hard nodules, not growing in the septa, but in the glandular substance of the testis. In their earliest stage these are merely hard semi-transparent granulations; but they soon show signs of undergoing fatty degeneration in the centre, so that the majority have the appearance of small bodies about the size of a millet-seed, having a yellow opaque centre, and a delicate greyish semi-transparent growing margin. Still nearer the corpus Highmori these yellow spots coalesce, and form a solid cheesy substance, continuous with a still larger mass of the same kind, which represents the epididymis, and half surrounds the body of the gland in the shape of a crescent. In this larger mass patches of softening are found forming the tubercular abscesses above described, and these may extend into the body of the gland. On making transverse sections of the vas deferens, its walls will be seen to be thickened, and its centre filled up with a yellow cheesy material. If the disease be further advanced, the whole gland may be converted into a single cheesy mass, in which softening may be taking place at various parts.

The exact nature of the change that takes place in the production of the condition above described, has given rise to much difference of opinion; some authors maintaining that the primary change consists in an overgrowth of the epithelium of the tubuli seminiferi and epididymis, which afterwards undergoes fatty degeneration; and others asserting that the primary growth takes place between the tubuli, and that the changes in the epithelium are secondary.

The accompanying drawing (Fig. 1001) represents a section of one of the small outlying nodules in the body of the gland, as described above. It will be seen that the change consists chiefly in an accumulation of small round cells in a more or less perfect reticulate stroma between the tubules, separating them from each other. At the same time the walls of the tubules have undergone a change, being infiltrated with cells in the same way as the surrounding parts. The tubules also are choked with epithelium, which in some parts of the same testicle was found to be undergoing fatty degeneration. Towards the centre of the nodule the intertubular growth also becomes caseous. Scattered through the new growth are many large masses of protoplasm containing many nuclei, the tubercular giant-cells. It is most probable, therefore, that the change commences in the vascular tissue between the tubuli seminiferi, and gives rise to secondary proliferation of the epithelium; both the intertubular growth and the proliferated epithelium afterwards undergoing fatty degeneration, and forming cheesy masses.

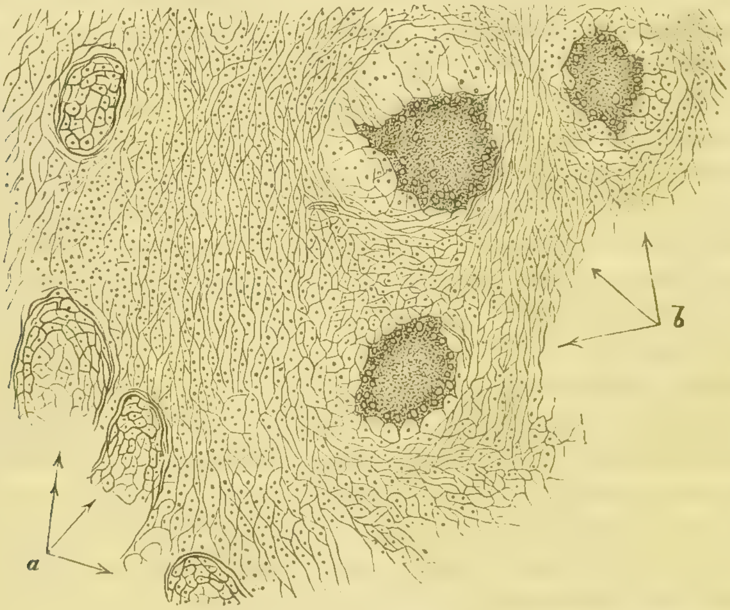


Fig. 1001.—Tubercular Testis. *a.* Tubuli seminiferi: *b.* Giant-cells (40 diam.)

Prognosis.—The prognosis of tubercular disease of the testis is extremely bad. Treatment is of little if any avail, and the patient in the great majority of cases dies sooner or later of disease of the lungs, from general acute tuberculosis or from extension of the disease to the bladder, prostate, and even to the kidneys. In some cases, however, after the abscesses have burst, the cavities may heal, and the testicle remain withered, but free from active disease.

Treatment.—The more I see of this disease the more convinced I am that the sooner the diseased organ is removed the better will be the patient's chance of prolongation of life. The danger of infection of the system by acute tuberculosis from a tubercular testis is so great, that when once the diagnosis has been made castration should not be delayed. In most cases however the operation is at best calculated to give the patient only temporary relief, as the disease usually extends along the vas deferens beyond the reach of the knife, and will continue to progress in the vesiculæ seminales and prostate, unless the patient succumb early to tubercular disease of the lungs or brain. Before undertaking it, the urine must be examined for pus, and the state of the prostate and vesiculæ seminales ascertained from the rectum, as the operation would, of course, be useless if the affection of the testicle were merely a part of tuberculosis of the whole genito-urinary tract. Should the patient decline to submit to the operation, or his health be so bad that its performance is not advisable, the treatment must be conducted on general principles ; alteratives, tonics, especially the iodide of iron, with cod-liver oil, and general hygienic means calculated to improve the health, must be steadily persevered with. Local applications are of little avail. The abscesses must be opened when they form. The cavity should be thoroughly scraped out with a sharp spoon and dressed with iodoform. Under this treatment it sometimes heals rapidly, but the cure is rarely permanent. If fungus form, it is of little use to try to treat it by the methods before described ; if the body of the testis be deeply infiltrated with tubercle, no good could result.

Syphilitic Orchitis, Syphilitic Sarcocele.—Syphilitic disease of the testicle appears under two forms, a simple inflammatory and a gummatous. The latter was formerly confounded with tubercle, under the name of tuberculo-syphilitic sarcocele, and the former is described by some authors with simple sarcocele. Both forms may occur either as the result of inherited syphilis in infants or of the acquired syphilis in adults. It is usually one of the later manifestations of the disease.

The **Simple Inflammatory Form**, which has been accurately described by Virchow, consists essentially of a chronic inflammatory overgrowth of the connective tissue between the tubuli seminiferi. The disease may uniformly affect the whole gland or be limited to localized patches. If the whole gland be affected, the organ slowly enlarges to perhaps more than double its natural size. The enlargement will be found to affect the body of the gland, the epididymis undergoing but little if any change ; in fact, it may be so far concealed by the thickening round it as to be scarcely recognizable. The cord and vas deferens are unaffected. The body of the gland feels hard, almost cartilaginous, and the surface is smooth or perhaps slightly irregular. There is no pain, except a dragging sensation in the groin due to the increased weight of the testicle. There is little or no tenderness, and in the more advanced stages the peculiar sensation caused by squeezing a healthy testicle is absent. There is no tendency to softening or to the formation of abscess. The disease is almost always accompanied by hydrocele, but at the same time adhesions may exist at various parts between the parietal and visceral layers of the tunica vaginalis, dividing the fluid into two or more portions, or limiting it to a small part of the surface of the testicle. Most commonly only one testicle is affected, but both may be attacked. In the localized form the induration is limited to one or more portions of the gland, the remainder being soft and healthy.

Structure.—On making a section from before backwards, the following appearances are found. If hydrocele exist, the tunica vaginalis will be opaque and thickened, and probably adherent at various points to the surface of the testicle. If no hydrocele be present, the tunica vaginalis may be uniformly adherent. The tunica albuginea will always be found greatly and irregularly thickened, and from it proceed opaque white dense fibroid processes into the substance of the gland. These may in extreme cases be so abundant that no healthy gland-substance can be seen between them; in less severe cases, patches of healthy tubular substance are found at various parts of the organ. A process of cicatricial contraction taking place in these fibroid processes may lead to a dimpling of the surface of the organ. The microscope shows that the change is due in an inflammatory small round-celled growth, which afterwards undergoes a development into a dense fibroid tissue, situated in the connective tissue between the tubuli seminiferi (Fig. 1003). The new growth separates and presses on the tubules, and may cause their destruction in large areas.

The **Gummatous Form** is an aggravation of that just described, and presents the same symptoms, with the addition of those caused by the presence of the gummata. These form hard craggy nodules on the surface of the gland, the irregularities so produced being much greater than those arising from simple fibroid induration. The gummata have little tendency to soften and discharge externally; yet in rare cases they may do so.

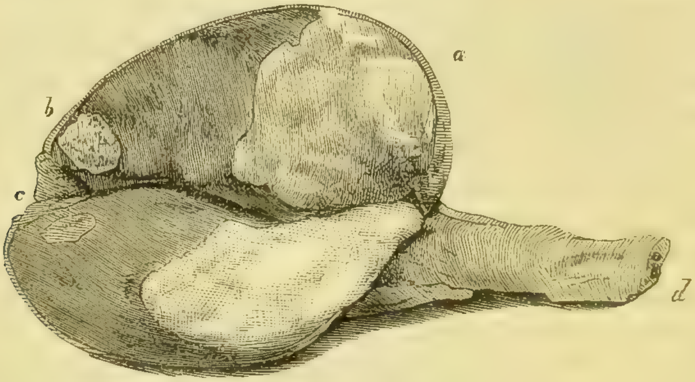


Fig. 1002.—Syphilitic Gummata of the Testis. *a*, *b*. Gummata cut across: c. Section of Globus minor: and *d*. Cord.

Structure.—On making a section of a gland in this condition, more or less of the fibroid induration, above described, will always be found combined with thickening of the tunics of the testicle. The gummata vary in size, from a pea to a hazel-nut. They are of an opaque yellow colour, irregular shape, and dense leathery hardness. They may be tolerably sharply circumscribed to the naked eye, but are usually surrounded by a zone of fibrous induration of an opaque white colour. The microscope shows around them the same small-celled growth above described, situated between the tubules. The new growth is vascular in the most recent parts. In the older parts the changes described in the chapter on Syphilis (p. 1127, Vol. I.) may be seen in their walls, causing their gradual obliteration. Nearer the centre the tubules are found to be pressed upon and destroyed, and the cells of the new growth commence to undergo degeneration; until, in the yellow part of the gumma, nothing but granular *débris* are to be recognized. The gummata may be distinguished from tubercle by their greater toughness and more opaque yellow colour. Tubercle is rarely limited to the body of the testis; gummata, on the other hand, rarely affect the epididymis.

Prognosis.—If the disease be recognized and treated early, complete recovery may be confidently hoped for; although relapses are of frequent occurrence.

In the more advanced stages, the prognosis is not so hopeful, for, although under proper treatment the new growth may be absorbed, the gland will remain shrunken, puckered, and indurated. This is only what would be expected; as the tubuli seminiferi, as above stated, become more or less extensively destroyed by the pressure of the new growth in the later stages of the disease.

The *Treatment* is that laid down in Chapter XXXVI. for constitutional syphilis. Locally, the hydrocele may be tapped (but on no account injected), and pressure may be applied, by strapping over some mercurial ointment.

Diagnosis of the Simple, Tubercular, and Syphilitic Sarcoceles.—The diagnosis of these affections is in some cases easy, in others very difficult. Whatever the form of disease may be, if it be complicated by hydrocele, this must first be tapped in order that the gland may be accurately examined. The hydrocele in these cases may not be translucent, as the tunica vaginalis is often thickened. It must be remembered that hydrocele is a very rare complication of cancer, or of cystic sarcoma; it is rare with tubercular sarcocele; less rare with simple chronic orchitis, and very common with syphilitic disease. From hæmatocele and tumours, the diagnosis may be made by attention to the rules laid down on p. 1237. It having been determined that the swelling is due to one of the three above-mentioned causes, it remains to ascertain which it is. This may be done by attention to the following points. The cord is often thickened and tender in simple chronic orchitis; in tubercular sarcocele, the vas deferens alone is affected, being frequently considerably enlarged; in syphilis the cord is perfectly healthy. In simple chronic orchitis, the epididymis may be swollen, but the chief enlargement is in the body; in tubercular disease, the epididymis is almost always the starting point of the disease, and is enlarged more than the body; in syphilitic sarcocele, the body is first and almost exclusively affected. In chronic orchitis, the enlargement is usually uniform and smooth, and fluctuation is rarely present; in tubercular sarcocele, the enlarged epididymis is craggy and nodular, and spots of softening may be felt; in syphilitic sarcocele, the body of the gland is greatly indurated, often nodulated, and softening is very rare. The testicle is usually painful and tender in chronic orchitis; in tubercular sarcocele it is sometimes tender,

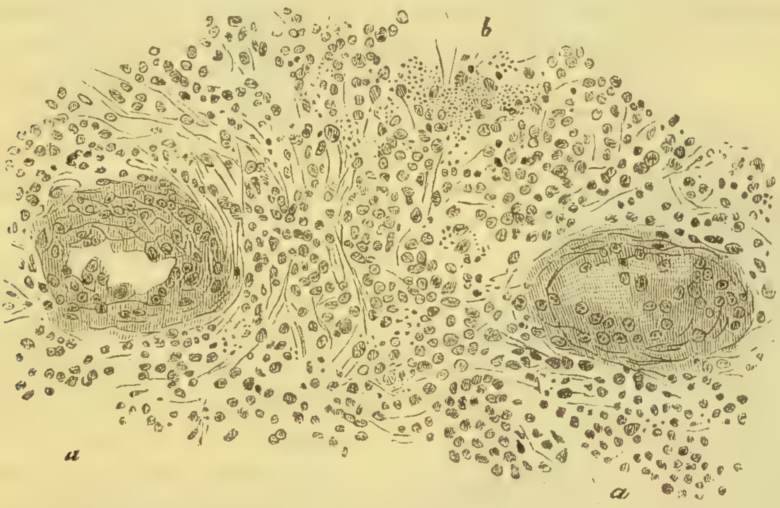


Fig. 1003.—Syphilitic Testis. *a.* Tubuli Seminiferi: *b.* A part of the round-celled growth beginning to undergo fatty degeneration (180 diam.)

seldom painful ; in syphilitic disease, it is almost invariably perfectly painless, and free from tenderness. The constitutional condition of the patient should also be carefully inquired into. Chronic orchitis usually arises as a sequence of injury, or perhaps gonorrhœa, in patients possibly strumous, gouty, or rheumatic ; tubercular disease occurs almost always in cachectic subjects, with a tubercular history and a tendency to phthisis. The lungs should therefore be carefully examined. In syphilitic sarcocele, the ordinary symptoms of constitutional syphilis may be present, or a syphilitic history may be obtained. In tubercular sarcocele, the vesiculæ seminales may often be felt through the rectum to be enlarged, and nodules of tubercle may be felt in the prostate.

TUMOURS OF THE TESTIS.

Adenoma Testis, or, as it is often called, **Cystic Sarcoma** or **Cystic Sarcocele**, is the most common non-malignant tumour of the testicle.

Structure.—The essential feature of this tumour is the presence of cysts varying in size from a cavity just visible to the naked eye to one as large as a walnut. Between these cysts is a varying amount of solid tissue. The whole tumour lies within the distended tunica albuginea, but on carefully dissecting it, it will be found to possess a delicate capsule of its own, between which and the tunica albuginea is a delicate layer of a pale yellowish brown colour, composed of the tubular substance of the testicle spread out over the mass of the growth. The attachment of the tumour will be found towards the mediastinum testis, and this suggests that the growth springs from the region of the rete testis, the cysts being believed to be derived from the obstructed and dilated tubes of that part of the gland.

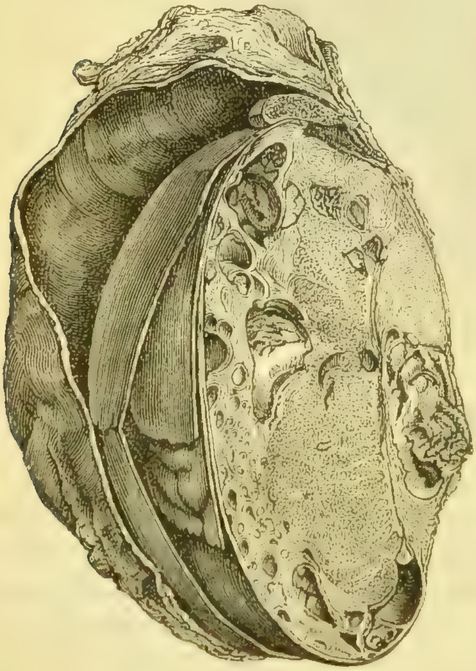


Fig. 1004.—Adenoma Testis. The external covering is the tunica vaginalis ; the next layer is the tunica albuginea ; the thin imperfect layer under this is the tubular substance of the testicle spread out over the true capsule of the tumour.

Microscopic examination shows that the cysts are lined with an epithelium, sometimes small and cubical, sometimes flattened. The interstitial tissue is composed of young connective tissue in various degrees of development.

The above is the type of the adenoma testis, but various modifications are met with. In the first place, the proportion of cysts to stroma varies greatly. The contents of the cysts may be clear and thin, or mucous and tinted, or stained with blood. More rarely they are filled with an atheromatous pulp. Occasionally some of the smaller cysts are filled with laminated epithelium forming pearl-like bodies.

The stroma may be purely composed of spindle-cells, or spindle and round cells mixed, or spindle-cells with a good deal of fibrous tissue between them. Almost invariably cartilage is present. It is usually in tortuous columns, which are clearly visible to the naked eye, and can be picked out of a thick section with a needle. It has been suggested that these columns of cartilage are lying in dilated lymphatics, but careful microscopic examination suggests rather that they are formed by chondrification of the embryonic matrix. The matrix in other cases may assume a myxomatous form, the intercellular substance being mucous in appearance and the cells stellate in form. In many cases the intercellular substance sprouts up into the cysts, forming intracystic growths still covered with epithelium. These tumours are usually simple and distinctly encapsuled, but in some cases they become malignant.

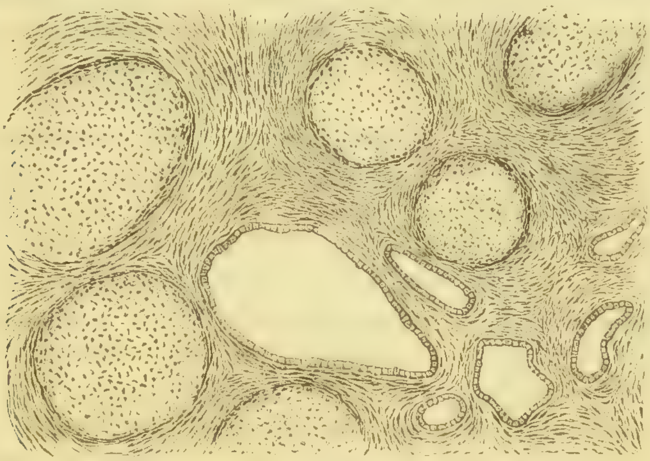


Fig. 1005.—Section of an adenoma testis showing the cysts, the embryonic interstitial tissue and the columns of cartilage.

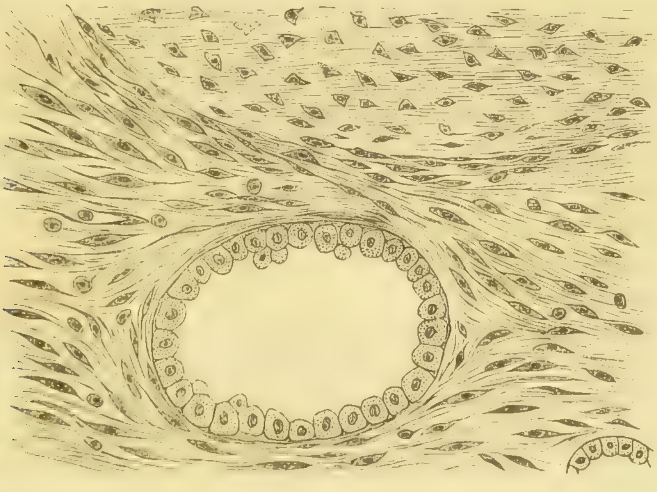


Fig. 1006.—Adenoma Testis more highly magnified, showing the stroma composed of spindle-cells and fibres, and the cyst lined with cubical epithelium and part of a column of cartilage.

This may occur from an exuberant growth of the embryonic tissue of the stroma, or, according to Rindfleisch, actual cancerous transformation may take place, the stroma assuming the form of a cancer-stroma and the epithelium of the spaces taking on the active growth of a true carcinoma. Many of these variations may occur in different parts of the same growth.

Symptoms.—These tumours are most common in young adults or middle-aged men, and are often attributed to a blow. They cause a steady increase in the size of the testicle, unaccompanied by pain or tenderness. Their growth is of varying rapidity, but they often take a year or more to attain any considerable size. They are firm and elastic, and fluctuating points can not uncommonly be detected in them. The cord is unaffected till a late period unless they become malignant. The epididymis is early flattened out by the growth and cannot be recognized. If not removed they may attain a very great size, and at last the skin covering them may give way and the growth may fungate and bleed.

Diagnosis.—The tumour is distinguished from hydrocele by its want of translucency, its more globular form and its weight. All doubt may be cleared up by an exploratory puncture.

Treatment.—The only treatment is early removal, always preceded by an incision into the mass to make sure that it is not a hæmatocele.

Enchondroma of the Testicle.—Cartilage, as before stated, is almost always present in the cystic sarcoma of the testis. It may, however, appear alone, in larger or smaller nodules, or infiltrating the gland. It usually commences in the body, and may invade the epididymis. According to Cornil and Ranvier, whenever it reaches any considerable size it is no longer purely cartilaginous, but is mixed with sarcoma-tissue and complicated with cysts, so that both clinically and pathologically it merges into the disease just described as cystic sarcoma.

Fibroma has been recorded, but is of extremely rare occurrence.

Sarcoma of the Testicle.—Pure sarcoma of the testicle without the presence of the cysts just described is not very common. It is indistinguishable from cancer before removal, presenting the same rapid growth, and softness of structure, giving rise to a smooth elastic globular or oval enlargement of the testicle. It is usually met with in younger subjects than cancer, sometimes even in young children.

Its microscopic structure varies in different cases. Small round-celled sarcoma is by far the most common variety, and often runs a very malignant course. Myxo-sarcoma with large spindle-cells intermixed with it, has been described. In very rare cases tumours containing striated muscular fibres mixed with spindle-cells have been found in the testicle. They exactly resemble the congenital tumours of the same structure met with in connection with the kidney.

The *Treatment* consists in early removal of the gland by castration.

Dermoid Cysts are occasionally met with in the testicle, usually in the body of the gland, causing atrophy of the tubular substance by their pressure. They are of course congenital, but are of very slow growth, and may not be noticed till adult life. They contain usually turbid fluid or an atheromatous pulp, often mixed with hairs. In other cases they may lie outside the gland in contact with the epididymis. A case of this kind occurred in University College Hospital lately in which the cyst, which was about the size of the normal gland, lay in contact with the globus minor. It was dissected away without injuring the gland.

In other cases fœtal remains may be found in the cyst. One of the most remarkable of these tumours that I have seen was under the care of my colleague Marshall, at the hospital. The diseased organ, which was about the size of an ostrich's egg, and felt partly solid and partly fluid, was found after removal to be composed of a large cyst filled with an oily fluid, like melted butter, which solidified on cooling. After removal Marshall found that the sac contained some fœtal *débris*, and was doubtless of an embryonic character. The patient, who was about thirty years of age, had been affected with the tumour from early infancy.

Cancer of the Testicle, or **Malignant Sarcocele,** not unfrequently occurs, and invariably assumes the encephaloid character.

Characters.—Cancer of the testicle most commonly occurs in the first instance in the body of that organ, rarely, if ever, affecting the epididymis primarily. The ordinary characters of encephaloid are always well marked in this affection ; and the tumour eventually fungates, becomes softened down, and pulpy. The mass on section is soft, pink in colour, with large yellow patches of fatty degeneration scattered through it. Its substance is often broken down in parts by hæmorrhage. It is impossible to distinguish it from a soft sarcoma without microscopic examination. The microscopic structure is that of encephaloid cancer. The stroma is small in amount but extremely vascular, and encloses spaces of great size filled with large cells of irregular form.

A malignant testicle may rapidly attain a very considerable magnitude, becoming as large as a cocoa-nut in a few weeks or months. When of this size it is, of course, abundantly supplied by blood-vessels ; consequently the spermatic artery and accompanying veins will be found a good deal dilated. The lymphatic glands in the neighbourhood speedily become enlarged, those in the iliac fossa especially, as may be ascertained by deep pressure in the flank. The inguinal glands do not in general become affected, until the skin has become implicated by the progress of the disease. It is then also that the cancerous cachexy rapidly develops itself.

The **Symptoms** of encephaloid of the testicle are usually somewhat obscure in the early stages, although they become clearly and distinctly developed as the disease progresses. It is most commonly met with after middle life. The patient first complains of some degree of dragging pain and weight in one of the testes, which on examination will be found to be indurated and enlarged, though preserving its normal shape. The enlargement continues until the testicle attains about the size and shape of a duck's egg, being somewhat tense and elastic, but smooth and heavy. As it increases in size, which it usually does with rapidity, it becomes rounded and somewhat doughy or pulpy in parts, where, indeed, it may almost be semi-fluctuating, though in others it continues hard and knobbed. This alteration in feel is partly due to softening of the substance of the tumour, and partly to its making its way through the tunica albuginea. The scrotum is much distended, reddened, and purplish, and becomes covered by a network of tortuous veins ; the cord may become somewhat enlarged, hard, and knotty. As the disease advances, the scrotum becomes adherent at some of the softened parts, ulceration takes place, and a fungus projects, which presents all the characteristic signs of fungus hæmatodes ; it does not commonly happen, however, that the disease is allowed to go so far as this before removal. The pain is not very severe at first, but after a time assumes a lancinating character, extending up the cord and into the loins.

Treatment.—The only treatment of any avail in encephaloid of the testicle, is the removal of the diseased organ. This operation is not performed so much with the view of curing the patient of his disease, which will probably return in the lymphatic glands or in some internal organ, as of affording temporary relief from the suffering and encumbrance of the enlarged testicle. It is therefore an operation of expediency, and should be done only in those cases in which the disease is limited to the testicle, the cord being free and the glands not evidently involved ; so that, if recurrence take place, it may not be a very speedy one.

An Undescended Testis may become the seat of a tumour, just as it may be affected by inflammation. The combination of malposition of the organ and a tumour is necessarily rare. But its possible occurrence must be borne in mind by the Surgeon, as it may lead to the necessity of an operation for the removal of the diseased mass from the inguinal canal. Cases of this kind are recorded by Storks and J. M. Arnott. The tumour in the first case was as large as a cocoa-nut ; in the second as a man's fist. Both were medullary. The operation consists in exposing the tumour by a free incision—if necessary, carried through the tendon of the external oblique—opening the tunica vaginalis, enucleating the mass, and tying with care the shortened spermatic cord, which would probably be the most difficult part of the operation. The possible co-existence of a congenital hernia must be remembered. But it is remarkable that peritonitis does not appear to be the chief danger of this operation. In neither of the cases above referred to did it occur, the patient dying of erysipelas in Arnott's case ; of recurrent cancer, a year after the operation, in that of Storks.

SOLID TUMOURS OF THE SPERMATIC CORD.

Fatty Tumours are not very uncommon. They most commonly occur as small isolated masses near the inguinal ring. They grow slowly and are of no importance except from their resemblance to hernia. The tumour can be pushed through the external ring, but it has no impulse on coughing, nor is there the characteristic slip and gurgle of a hernia as it goes back. Large lipomata invading the scrotum as well as the cord have also been recorded.

Fibromata and Myxomata of the Cord have been recorded, but are merely pathological curiosities.

Sarcomata have also been met with in this region.

OPERATION OF CASTRATION.

This operation may be required for the various non-malignant affections of the testicle that have resisted ordinary constitutional and local treatment, and have become sources of great annoyance and discomfort to the patient ; in the early forms of malignant disease, also, it may be advantageously practised. The operation is performed in the following way. The patient, having had the pubes shaved, should lie upon his back with the legs and thighs hanging over the end of the table. If the tumour be of large size and vascular, an india-rubber tourniquet may be applied (Fig. 10, Vol. I., p. 45). The Surgeon should then take his stand in front of the patient between his legs, and, grasping the tumour at its posterior part with his left hand, make the scrotum in front of it tense. If the mass to be removed be of small size, he makes a longitudinal incision over its anterior surface ; if of large size, or if the skin be implicated, two curved incisions, enclosing a portion of the scrotum. The incision should commence opposite the external abdominal ring, and be carried rapidly down to the lower part of the scrotum. By a few touches with a broad-bladed scalpel or bistoury, whilst the skin is kept upon the stretch, the tumour is separated from its scrotal attachments, and left connected merely by the cord, which must then be divided. In some cases, it will be found advantageous to expose and divide the cord in the first instance, before dissecting out the tumour from the scrotum, as in this way a better command over it is obtained.

The **Division of the Cord** constitutes the most important part of the operation, whether this be done first or last ; as, unless care be taken, the cord may be retracted through the abdominal ring into the inguinal canal, where it is extremely difficult to follow it, and where the stump may bleed very freely, pouring out blood into its own areolar tissue so as to swell up rapidly and form a large extravasation of blood, and, if not properly secured, giving rise to extensive and even fatal infiltration into and between the muscles of the part and into the flank. This accident may be prevented by separating the cord cleanly from the sheath—more especially from the cremasteric fibres which are the chief causes of the retraction. It may then be seized with a pair of clamp-forceps, or tied tightly with a tape (Fig. 1007). It is very slippery, and apt to slip through the assistant's fingers, hence the use of the clamp or tape. It may then be cut across below this and the arteries tied separately. The veins must be tied as well as the arteries. The arteries requiring ligature are usually the spermatic, the cremasteric, and the artery of the vas deferens. The spermatic artery will be found at its anterior part—the artery of the vas deferens behind. When all the vessels are secured the tape or clamp must be removed.

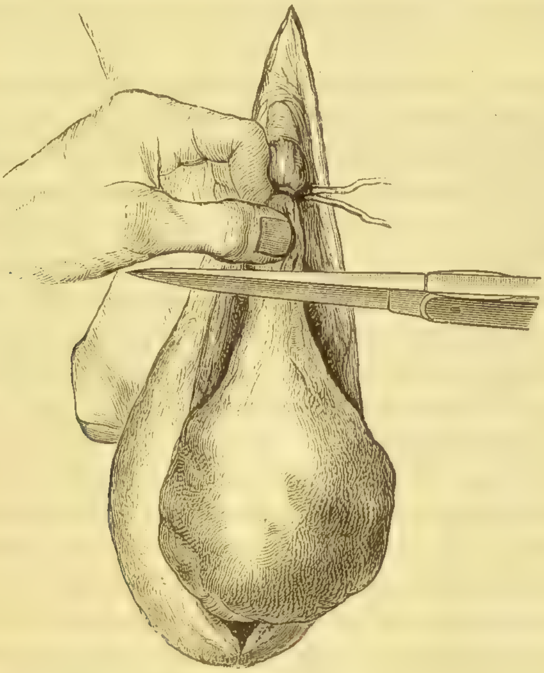


Fig. 1007.—Division of the Cord in Castration.

If the Surgeon has not a very reliable assistant it is safer to tie the cord as a whole. This is done by passing a piece of strong carbolized silk under the cord, and tying the whole of this structure very tightly before dividing it. In this way hæmorrhage is most effectually restrained; and the ligature separates about the eighth day, or may heal into the wound if cut short, provided efficient antiseptic treatment is carried out.

In castration for tubercular testicle it is better to separate the vas deferens from the other constituents of the cord and to divide it separately. If it be found diseased it may be drawn down and a further piece removed in the hope of getting above the disease.

A large number of vessels usually require ligature in the scrotum. All bleeding from this source must be very thoroughly arrested, otherwise the loose tissues of the scrotum may become distended with extravasated blood and very troublesome suppuration result. After the operation the wound must be accurately closed with sutures and a good-sized drainage-tube inserted at its lower end.

In cancer of the testicle, it is of great consequence to divide the cord as high up as possible, for obvious reasons. It will not, however, be safe to do this opposite the abdominal ring in the way that has just been described, as there would not be sufficient space for the assistant to hold the cord above the part to be divided. In cases of this kind, I have found it a good plan to expose the cord by dissection up to the abdominal ring; then to draw it well down, and to include the whole in a strong ligature, tied round it as tightly as possible. The section is then made a quarter of an inch below this, and the operation is completed as usual; the stump of the cord may retract into the inguinal canal, but cannot bleed if properly tied, and will always be under command by drawing upon the ligature. This plan of tying the cord *en masse* was at one time generally adopted in all cases of castration, but is not now commonly employed. The objection to it is, that by compressing the nerves of the cord with the ligature the after-pain is increased; but this certainly does not always happen, for, in the instances in which I have done it, but little pain was complained of; and the practice in malignant disease of the testicle has the advantage of enabling the Surgeon to divide the cord at a higher point than he otherwise could; which advantage is still further increased by the parts within and below the ligature sloughing away, and thus eventually carrying the section to a level with the point tied.

There is one danger that may occur in castration in children. It is that in young subjects the processus vaginalis testis may not be obliterated, and that thus the peritoneum may be opened up into the wound on dividing the cord. In one case I have known this condition to lead to fatal peritonitis.

GENERAL DIAGNOSIS OF SCROTAL TUMOURS.

The diagnosis of scrotal tumours is not only of considerable importance, but is often attended with very great difficulty; the more so, as they are frequently associated with one another, so that much tact and care are required to discriminate their true nature. Thus it is not uncommon to find a hydrocele and a hernia; a hydrocele and a varicocele; or these affections co-existing with a solid tumour of the testicle. In other cases, again, as in the annexed figure (1008), an encephaloid tumour may co-exist with a hydrocele of the tunica vaginalis, and with an encysted hydrocele of the cord; and the different forms of hydrocele may occur together.

Tumours of the scrotum may, from a diagnostic point of view, be divided into two distinct classes :—1, the Reducible; and 2, the Irreducible.

1. **Reducible Tumours.**—These are Hernia, Congenital Hydrocele, Diffuse Hydrocele of the cord, and Varicocele; in all of which the swelling can be made to disappear more or less completely by pressure and by the patient lying down; reappearing on the removal of the pressure, or on his assuming the erect posture. The mode in which the tumour disappears, tends greatly to establish its diagnosis; though the general character of the swelling, and the history of the case, afford important collateral evidence on this point.

a. In **Hernia** there are the ordinary signs of this affection, such as impulse on coughing, &c. On reducing the tumour, it will be found that its return into the abdomen is accompanied by a gurgling noise, and by the sudden slip upwards of an evidently solid body. In the other reducible tumours, the diminution and eventual disappearance under pressure are more gradual, and there is no reduction of the mass as a whole.

b. The gradual squeezing out of the contents of a **Congenital Hydrocele,** together with its translucency, and the early age at which it occurs, will establish its true character. It must be remembered, however, that herniæ in very young infants may be translucent if the gut contains little or no fæcal matter.

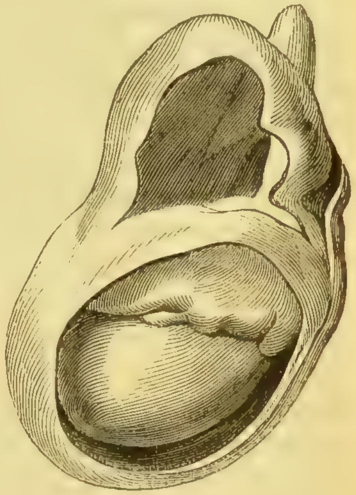


Fig. 1008.—Encephaloid Testicle with Hydroceles of the Tunica Vaginalis and of the Cord.

c. In the **Diffuse Hydrocele of the Cord,** there is a uniform semi-fluctuating swelling in and near the ring; in which, however, there is no gurgling, &c., no complete reduction nor sudden disappearance as in hernia. It is also less defined, and has a less distinct impulse on coughing.

d. **Varicocele** may always be distinguished by its pyramidal shape, and its knotted, soft, and irregular feel. After being reduced when the patient lies down, it will, when he stands up, fill again, even though the Surgeon compress the external ring with his fingers. This sign, which distinguishes it from a hernia, occurs also in congenital hydrocele; from which, however, the varicocele may be distinguished by the absence of translucency, the want of fluctuation, and the general feel of the tumour.

2. **Irreducible Scrotal Tumours** are of various kinds; such as Omental Hernia, Hydrocele, Hæmatocele, the various forms of Sarcocele, and Cancer of the Testicle. These tumours, though presenting certain characters in common, yet differ somewhat in the predominance of particular signs. Thus, the shape of the tumour is usually pyriform in hydrocele, globular in hæmatocele, and oval in sarcocele; though this is subject to much variation. The weight is least in hydrocele and greatest in sarcocele, proportionately to the size of the tumour. The characters of the surface present considerable differences, being smooth and tense in hydrocele and hæmatocele; often irregular, hard, or knotted in the other varieties. The rapidity of the formation of the tumour is greatest in hæmatocele.

a. **Irreducible Scrotal Hernia** may be recognised by its irregular feel, by its impulse on coughing, by its occupying the canal and concealing the cord, and by the testicle being distinctly perceptible below it.

b. **Hydrocele of the Tunica Vaginalis** is recognizable by its translucency; and the amount of opacity conjoined with this will enable the Surgeon to distinguish the degree of enlargement of the testis, and how far there is a sarcocele conjoined with it.

c. In **Hæmatocele** the tumour is of sudden or rapid formation, somewhat globular, opaque, but not very heavy or hard, and smooth upon the surface.

d. In **Sarcocele** generally the tumour is heavy for its size, frequently globular or irregular in shape, sometimes knobbed, and usually attended by a good deal of dragging pain in the groin, and frequently by some enlargement of the cord.

In these three forms of scrotal tumour, viz., hydrocele, hæmatocele, and sarcocele, the diagnosis can always be made at once from hernia, by the Surgeon feeling the cord free above the tumour.

The point of most importance in the diagnosis of solid enlargements of the testicle is to distinguish the malignant tumours, sarcoma and cancer, from other forms of disease. In malignant tumours, rapidity of growth, softness and elasticity of the mass, the implication of one testis only, and the early enlargement of the cord, with its indurated and knobbed condition, are important signs; especially if the disease occur in young men. In a more advanced condition, the softening of the swelling at parts with a tuberous condition of the rest, and the occurrence of fungus with speedy constitutional cachexy, will point to the malignant nature of the tumour. In cases of much doubt and difficulty an exploratory puncture may be made, when the contents of the groove in the needle or of the fine cannula will probably determine the character of the growth. In more than one instance, in which there was much obscurity, I have seen the true nature of the disease cleared up in this way.

SPERMATORRHŒA AND IMPOTENCE.

Various forms of debility, of loss of power, or of irregularity of action in the generative organs of the male, are confounded together under the terms **Spermatorrhœa** and **Impotence.** These conditions require a more careful consideration on the part of the educated Surgeon than they have hitherto received, as their existence is a source of the deepest mental depression and distress to the sufferer. They are certainly one cause of conjugal unhappiness, leading perhaps to infidelity on the part of the wife, and occasionally even to suicide of the husband. These affections, which are of extreme frequency amongst all classes of the community, having scarcely as yet received that attention on the part of the profession generally which their importance deserves, the unfortunate sufferers from them are too often driven into the hands of those pestilent quacks who flourish in the metropolis, and infest almost every town in the country, by whom they are not unfrequently ruined in health as well as in purse.

The **Sexual Melancholia** that accompanies these conditions, is one of their more striking characteristics. The patient is languid in manner, depressed in spirits, his countenance is pale and haggard, eye dull, expression listless, and devoid of all energy. He takes no interest in the ordinary affairs of life, his whole thoughts are concentrated on his own condition, and he feels himself degraded as being unfit for that duty which is alike the first and the lowest of man. This state of mind is commonly the result of some local irritation or disease, re-acting on a morbidly sensitive nervous system; and on examination, the Surgeon will commonly find some local condition that has been the starting point of the mental malady. Balanitis, phimosis, or varicocele in the male are the common occasioning causes. But the most frequent direct exciting cause is undoubtedly that pernicious and disgusting habit alike destructive of bodily vigour and of mental power, which, heedlessly contracted in youth, lays the foundation for an effete and impotent manhood, and for premature senility in the one sex, and entails hysteria, in its most aggravated and intractable forms, in the other.

We may recognize at least three distinct varieties of generative debility in the male, of whom I alone speak, which may in some cases amount to actual impotence: 1, True Spermatorrhœa, or Seminal Flux; 2, Spasmodic Spermatorrhœa, or Spermatospasmos; and, 3, that arising from Want of Seminal Secretion, or Aspermia.

1. **True Spermatorrhœa,** or **Seminal Flux,** is a rare disease, and is met with chiefly in young men, usually from the ages of eighteen to thirty. It is commonly the consequence of masturbation, or of debility of the generative organs induced by gonorrhœa, or of the continued struggle to repress the natural sexual desires by a life of forced or unavoidable continence. In this form of the disease there is a mixture of irritability and of debility. The generative organs are excited by slight emotional causes, or by trivial and ordinary physical stimuli—a thought, a look, a word, the movement of a carriage, the effort of straining at stool, will excite the secretion of the testes, which the debilitated state of the parts allows to escape with a feeble ejaculatory effort, or in a kind of leakage of a few drops from the urethra. In the slighter cases, and in the earlier stages of the malady, these emissions take place but occasionally—three or four times a week, chiefly in the morning, in the mid state between waking and sleeping, and are preceded by an erection. In the more advanced stages, the emissions occur once or oftener in the twenty-four hours without an erection; the semen at last, when discharged, flowing back into the neck of the bladder, escaping with each discharge of the urine, or being squeezed out after defæcation. The patient's physical and mental state becomes seriously implicated in these more advanced cases of true spermatorrhœa. His countenance is pallid, anæmic, and sallow; his features are drawn, their expression is listless; his eyes lifeless; his spirits depressed, often to the lowest depths of despondency and despair. Connection is impracticable, as the discharge of semen takes place either before erection occurs, or without its occurrence.

Diagnosis.—The first point in making a diagnosis is to ascertain that there is some real disease, and that the patient is not merely the subject of hypochondriasis or sexual melancholia. Various conditions are mistaken for spermatorrhœa by a nervous patient. The white discharge of phosphates occurring at the end of micturition (p. 988), when the urine is alkaline in some forms of dyspepsia, is often believed by the patient to be seminal fluid; and as this condition is frequently accompanied by the languor of dyspepsia, and is common in those who sit up too late at night and overwork themselves, this harmless condition may give rise to the deepest mental depression.

Prostatorrhœa (p. 1008, Vol. II.) is very apt to be confounded with spermatorrhœa; but the diagnosis may always be effected by a microscopical examination of the discharge.

An occasional involuntary emission is not spermatorrhœa. It is common to young men of an ardent and excitable temperament, and is often the occasion of much groundless alarm. It occurs at that period of life when the generative power and sexual feeling are at their highest point of development. It is simply the result of a hypersecretion of the testes and overflow of the semen. For its repression, moral advice and medicinal agents are equally unnecessary and unavailing. For it, early and congenial marriage is the only remedy. Unless this be adopted, Nature will assert herself—she is indifferent to social considerations—she will enforce her rights in spite of all restraint. "Naturam expellas furcâ, tamen usque recurret."

The escape of a small quantity of seminal fluid from the vesiculæ seminales while straining at stool is of common occurrence in young men leading a continent life; it need cause no anxiety, and requires no treatment beyond a purge and a cold hip-bath.

Frequent nocturnal emissions in many cases are merely a symptom of dyspepsia, the languid feelings of which the patient complains being very often due to this much more than to the loss of semen. The loss of semen by an involuntary emission causes no more depression than a corresponding loss during coition, and if occurring not more than twice a week has no evil effect. It is the constipation and dyspepsia accompanying it, that are the real source of the symptoms complained of.

Treatment.—The curative treatment of true spermatorrhœa should consist in giving tone to, and in lessening the irritability of, the genito-urinary organs. In these cases it becomes necessary to maintain and improve the tone of the system by remedies calculated to remove the anæmia and to stimulate the nervous energies. With this view, the preparations of iron, phosphorus, nux vomica, and cantharides will be found the most effective. The syrup of the phosphate of iron and strychnine, or the tincture of the perchloride of iron, in combination with those of nux vomica and cantharides, will be found of the greatest service. But under any form of treatment the cure will be slow, and long-continued perseverance in the use of remedies, local and constitutional, is imperatively necessary. In addition to these means the cold hip-bath should be assiduously employed. This the patient should use every night and morning; remaining in it, at first, for about three minutes, but gradually increasing the time of immersion to ten or fifteen. The patient must sleep on a hard mattress, be lightly covered, and eat no supper. Some satisfactory mental occupation should also be provided, or travelling if possible. In some cases the cold shower-bath appears to give more tone, and then should be preferred. These means, useful as adjuncts, will not, however, cure the patient. For this purpose, the local irritability must be removed by the application of the nitrate of silver to the prostatic and bulbous portions of the urethra. It will usually be found that there is a good deal of tenderness in these situations, felt on pressing upon the perinæum, or on passing an instrument into the urethra, when, as the point enters the bulb, the patient will suffer much pain. The continuance of this irritation certainly keeps up the seminal emissions, and thus maintains the debility of the genital organs, and the nervous irritability, that are so characteristic of these cases. It may most effectually be remedied by the application of the nitrate of silver, as originally recommended by Lallemand; and if this be done in a proper manner, a cure will usually be accomplished. For many years past I have employed, with much advantage in such cases, the instrument here figured (Fig. 1009). It consists of a silver catheter, having about a dozen minute apertures near the end. In the interior is contained a slender piece of sponge, about two inches long, fixed to the expanded end of a firm stylet that moves with the catheter. The instrument is charged by filling the sponge with some solution of nitrate of silver by withdrawing the stylet. It may then be well oiled; and, being passed down to the spot to be cauterized, the solution is forced out of the aperture by pushing down the rod, which compresses the sponge. I have found this syringe-catheter far safer and more manageable than Lallemand's or any other *porte-caustiques* that act by protruding a spoon or sponge, which is apt to be grasped by the spasmodic action of the muscles of the part, often being returned with difficulty into the shaft, and not without risk of lacerating the mucous membrane. I generally use a solution of the strength of ʒj of the nitrate to an ounce of water; though sometimes only a half or a third of this strength can be borne. The application usually occasions a good deal of irritation for a time, sometimes even a muco-purulent discharge, and can be repeated only at intervals of from ten days to a fortnight. Any undue amount of irritation, particularly after the application, must be subdued by ordinary antiphlogistic treatment. After the nitrate of silver has been used two or three times, the treatment may be advantageously continued by passing twice a week a similar instrument charged with glycerine of tannin. This acts as an admirable astringent, and suits many people better than the nitrate.

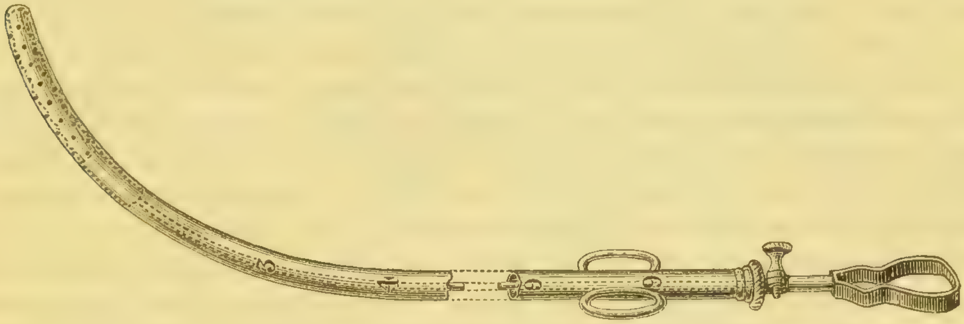


Fig. 1009.—Syringe-catheter for applying Caustic to the Urethra.

2. **Spasmodic Spermatorrhœa,** or **Spermatospasmos,** more frequently occurs between the ages of twenty-five and forty. It is frequently predisposed to by residence in a warm climate, or by the existence of some disease about the generative organs; such as stricture, varicocele, neuralgia testis, &c. In these cases, there is not, properly speaking, a seminal flux; but complete connection cannot be effected, as erection and ejaculation are either simultaneous acts or the erection partially subsides before the emission takes place. This form of generative debility is often as much dependent on mental or moral as on purely physical causes.

Treatment.—This is a condition of irritability rather than of debility. It often occurs in strong and otherwise healthy men, accustomed to field-sports and out-of-door exercises. There is no evidence of anæmia or of debility of any kind. Hence tonics are not necessary. The remedy most to be relied upon is the bromide of potassium in doses of 20 to 30 grains, with local cold bathing, and, perhaps, when there is urethral irritation, blisters to the perinæum and along the penis, with belladonna to the interior of the urethra. In addition to these means, it is of the first importance to enjoin moderation in food and drink, and above all, avoidance of alcoholic stimuli ; for, in many of these cases, it will be found that abdominal plethora co-exists, and exercises an injurious influence.

3. **Impotence** arising from absence of all sexual desire or power, or from premature decay of that power, is not unfrequently met with, and often in individuals who are otherwise strong and healthy; sometimes, indeed, in those characterized by great muscular power, and much given to athletic exercises. This want of sexual desire may be looked upon in many instances as a natural deficiency in the organization of the individual, for which medical or surgical treatment can do little. In other cases it arises from exhaustion of the nervous system by habitual physical or mental over-exertion, by excessive sexual indulgence, over-training, or study carried to too great and injurious a degree. Complete absence of seminal secretion—*Aspermia*—except in cases of atrophy or absence of the testes, must be especially rare. In a patient of mine who died at 54 years of age, and who, according to his own and his wife's account, had been completely impotent for the twenty-four preceding years, spermatozoa in considerable quantities were after death found in the testes, which were carefully examined with the view of ascertaining whether they ever secreted semen. Retention of both testicles, or atrophy of both glands from mumps, will of course cause impotence. Temporary impotence from nervousness is not uncommonly met with in young men immediately after marriage. In these cases the treatment recommended by Sir A. Cooper, of ordering some harmless medicine, and forbidding the patient to attempt connection, will usually be effectual.

Sterility in the male is a condition that has attracted some amount of attention of late years. It is, of course, not unfrequently connected with, and probably dependent on, the same conditions that give rise to the various forms of sexual debility that have just been described. But it may occur independently of any of these states, in individuals, indeed, who are possessed of a very considerable amount of sexual desire and vigour. It would appear to be due to some morbid condition of the seminal fluid, in consequence of which the spermatozoa are either absent, or are possessed of insufficient vitality to effect impregnation. The causes of this condition are very obscure ; but over-indulgence in sexual intercourse appears to be amongst the most frequent. It would seem as if each individual were endowed with a certain amount of procreative power, which, if early exhausted, or habitually wasted in indiscriminate intercourse cannot be restored. Hence, Polygamists in the East, or their Western congeners, do not propagate, as a rule, more than the average number of children. Amongst organic causes of this state, chronic epididymitis appears to be the most frequent (p. 1206). The only *Treatment* that can be adopted with any prospect of success, is in the one case prolonged avoidance of sexual excitement, and in the other the removal of local disease existing in the urethra or testis, such as stricture, or thickening or condensation of structure, by the long-continued use of absorbent remedies on general principles. Tonics are valueless in such cases.

Sterility arises also from malformation of the penis, such as complete hypospadias, and more rarely from the size of the male organ rendering complete coition impossible.

In conclusion I need scarcely say that, in the treatment of that general melancholia or hypochondriasis which accompanies these various affections, much good may be effected by means that directly influence the spirits and the mental condition of the patient. He should be encouraged to travel, to occupy himself with healthy out-door pursuits and amusements, to take regular exercise, to avoid all enervating habits ; and, above all, his mind should be cheered by the hope of eventual cure. Should there be any local disease, such as balanitis, phimosis, or varicocele, that should be subjected to treatment or operation.

CHAPTER LXXV.

DISEASES OF THE FEMALE GENITAL ORGANS.

Some important surgical affections of these organs, such as vesico-vaginal and recto-vaginal fistulæ, lacerated perinæum, &c., have already been discussed. The remaining affections, implicating the Vagina, the Uterus, and the Ovaries, are of the greatest practical interest; but, as their full consideration would lead me far beyond the limits that can be assigned to them in this work, and, indeed, belongs to another department of Medicine, I must content myself with a brief indication of the principal surgical points deserving attention.

INTRODUCTION OF INSTRUMENTS.

Speculum Vaginæ.—Vaginal specula of various shapes and materials are commonly used by Surgeons. When the os and cervix of the uterus require exploration, the most convenient instrument is certainly the cylindrical reflecting glass speculum (Fig. 1010); which, being coated with a layer of tinfoil, covered by india-rubber, always presents internally a mirror-like surface, by which a strong body of light is thrown into the bottom of the tube. It has the additional advantage of being very cleanly, and not stained by any caustics that may be used in it. These specula should be of different sizes, and may be sometimes advantageously bevelled off at the inner end.

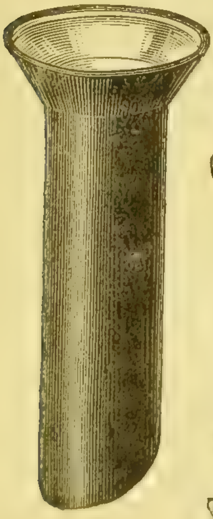


Fig. 1010.—Cylindrical Speculum.

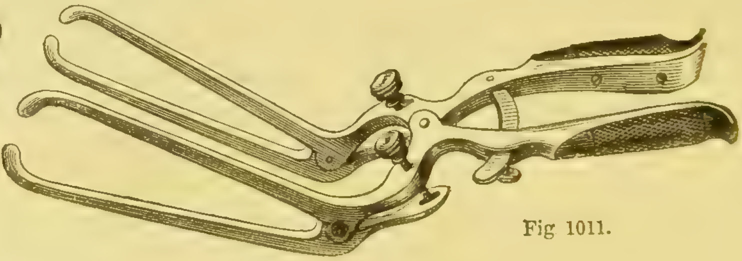


Fig 1011.

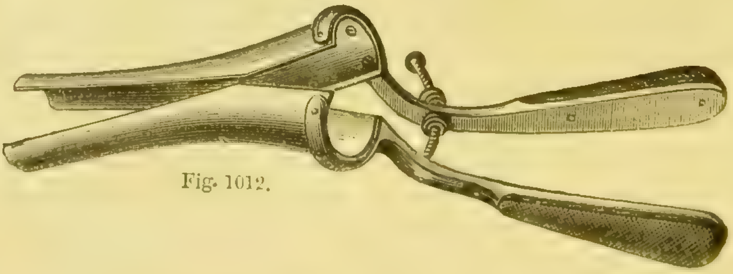


Fig. 1012.

Fig 1011.—Branched Speculum. Fig. 1012.—Bivalve Speculum.

When the wall of the vagina requires examination, as in some operations for fistula, a bivalve speculum (Fig. 1012), one with expanding blades (Fig. 1011), a cylindrical one, provided with a sliding scale, or the "duck-billed" speculum (Fig. 969) may advantageously be used.

Introduction of the Speculum may readily be effected, without any exposure of the person, under the dress or bed-clothes. There are two positions in which the patient may conveniently be placed for this purpose. In the first, she lies upon her back, with the nates well raised and brought to the edge of the bed or couch, her legs separated, and her feet resting on two chairs; the Surgeon, standing or sitting in front of the patient, separates the labia with the thumb and forefinger of the left hand, and then passes the speculum, well greased, gently and steadily between and under them, exerting any pressure that may be required *backwards* on the perinæum. This position is the most convenient when caustics require to be applied; but is often objectionable to the patient, as it appears to entail much exposure, though in reality it need not do so. Another mode of introducing the speculum, which should always be adopted when practicable, consists in placing the patient on her left side across the bed, with the knees drawn up, and the nates near the edge; the instrument is then introduced in the same way as before, the Surgeon sitting by the patient's side. In whichever way the speculum is used, no force should be employed; the patient should be placed opposite a good light, and care should be taken that the instrument be introduced fairly to the uterus, the position of which may have been previously ascertained by tactile examination.

Female Catheter.—The use of the female catheter is often required in various diseases and operative procedures about the genito-urinary organs of women. It should be introduced without exposure, by the aid of the touch alone. This may readily be done, as the patient lies in bed, under the clothes. The Surgeon, standing on her left side, passes his left index finger downwards between the nymphæ until he feels the projection of the meatus urinarius, immediately above the entrance into the vagina; keeping his finger just below this, he uses it as a guide to direct the point of the catheter into the canal. Or the reverse way may be adopted; the Surgeon, passing his finger within the orifice of the vagina, feels the urethra like a cord under the arch of the pubes; on tracing this forward, the urethral orifice is readily detected, and the catheter is slipped in. This method has the advantage of avoiding the clitoris, a matter of importance in hysterical females. The catheter here depicted (Fig. 1013) is fitted—when in use—with rubber tubing, through

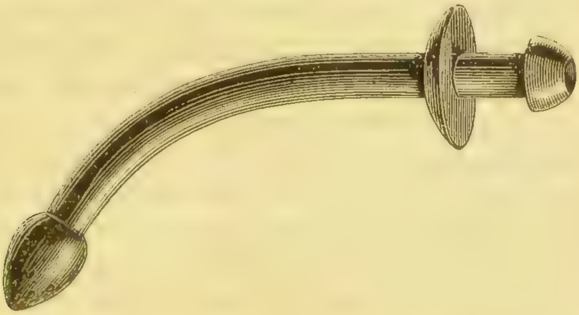


Fig. 1013.—Self-retaining Female Catheter (Vulcanite).

which the urine flows into a vessel beneath the bed containing some disinfectant fluid.

DISEASES OF THE EXTERNAL ORGANS AND VAGINA.

The vulva is the seat of numerous morbid conditions, consisting principally of hypertrophy or of warty growths, or the formation of cysts.

Hypertrophy of the Labia to a limited extent is not unfrequently met with, one labium hanging down considerably below the other. In these cases, it will often be found that the enlargement is due to a kind of solid œdema, originally dependent, perhaps, upon a fissure or ulcer of the part. In other cases, large fibro-cellular tumours form as outgrowths from the natural structures in this region; these may require removal by excision.

Large Condylomata or **Verrucæ** are often met with here as the result of gonorrhœal or syphilitic disease, forming at last irregular pendulous masses which require extirpation, either by knife or scissors, or by means of the cautery. I have had occasion also to remove a large *Nævus* by ligature from this situation; and, in fact, any growth that occurs in the skin or cellular tissue may be met with here.

Cystic Tumours are not unfrequently met with in the labia, and may sometimes resemble rather closely the ordinary forms of inguinal hernia; with which, however, their incompressibility, irreducibility, and the absence of impulse on coughing, will prevent their being confounded. These cysts, which require removal by a little simple dissection, usually contain a clear glairy fluid, the retained secretion of the vulvo-vaginal gland; sometimes, however, the fluid is turbid and of a dark brownish hue. Tolerably free hæmorrhage may follow their removal, the vascular tissues of the labia being cut into. This may, however, always be arrested by Paquelin's or some other form of cautery, or by firm pressure by means of a T-bandage. Occasionally they project from the inside of the vagina, and then require removal by dissection or ligature, as can be best practised.

Imperforate Vagina, as usually met with in young children, occasions a good deal of anxiety to the parents. This condition, however, may always be very readily and speedily removed by tearing open the canal, as it were, by dragging open its walls in opposite directions, and breaking through the adhesions, which are little more than epithelial, with the thumb-nail, a blunt probe, or the handle of a scalpel, and then introducing a small pledget of greased lint.

Imperforate Hymen is occasionally met with, causing great inconvenience, and even danger, by the retention of the menstrual secretion, which may accumulate to an immense extent, and become converted into a kind of chocolate-coloured grumous fluid. This malformation does not usually attract attention until the age of seventeen or eighteen. When the menstrual flux has, however, not appeared, notwithstanding periodical constitutional disturbance, an examination is made, and the cause of the obstruction is revealed. In these cases the hymen, which forms a dense elastic membrane, is pushed down between the labia, and the uterus distended by accumulated secretion may generally be felt as an elastic fluctuating tumour above the pubes, reaching sometimes nearly to the umbilicus.

Treatment for the relief of this condition is best undertaken during the interval between two menstrual periods, as indicated by the recurrence of the molimina. The operation required, unless carefully performed, is by no means free from risk. The patient having been placed in the lithotomy position, the parts are first thoroughly cleansed with an antiseptic solution. A vertical incision, one inch in length, is next made in the region of the hymen, by cautiously dividing the obstructing tissues, layer by layer, until the retained fluid is reached. The use of Paquelin's knife for this purpose is preferable to that of an ordinary scalpel. In opening the membrane, it need scarcely be said that wound of the urethra should be carefully guarded against; with care, this accident may always be avoided. I have, however, seen one case in which it had occurred. Once a free opening has been made, the cavity must be allowed to empty itself without the assistance of any pressure from above. When the fluid has ceased to flow, a pad of iodoform gauze or lint soaked in carbolized oil, is laid over the vulva and supported by a napkin. The dressing should be changed as often as may be rendered advisable by the amount of discharge. The use of the catheter is usually required for a day or two after operation. The patient should remain in bed for at least a fortnight.

Occasionally the Surgeon's advice may be sought by married women, for a rigid and only **Partially Perforate Hymen**; when incision with a probe-pointed bistoury or forcible dilatation may be required. Impregnation, however, is possible, even though the hymen be not ruptured; and it may be necessary during parturition actually to complete the division of that membrane, if thickened and unruptured, though in most cases it gives way under the pressure of the fœtal head.

It may happen that surgical aid is needed to supplement conjugal efforts in the consummation of the marriage rite. In these so-called "delicate" cases, anæsthesia having been induced, the Surgeon introduces a small bivalve speculum shut (Fig. 1012), or an ordinary "glove-stretcher," and, expanding the blades, ruptures the hymen, and dilates the vagina to the necessary extent as he withdraws the instrument. When severe spasmodic pain, of the character known as vaginismus, is habitually caused by coition, its origin, failing other causes, may occasionally be traced to a hyperæsthetic condition of the remains of the hymen. In such cases, excision by means of curved scissors of a complete ring of the sensitive tissue seated immediately within the entrance of the vagina, usually serves to cure the affection; and this all the more surely if followed by forcible dilatation of the part and the introduction of a firm plug of iodoform gauze, which should be allowed to remain *in situ* for several days.

Absence of the Uterus and Ovaries, with imperforate vagina, is occasionally met with in women otherwise perfectly well formed; the external organs of generation, labia, and nymphæ being present, and the breasts developed. In such cases, it is remarkable that sexual desire usually exists. The true condition may be detected by an examination *per rectum,* and especially by the introduction of a catheter into the bladder whilst the finger is in the rectum, when the two cavities will be found to be in close apposition without the intervention of uterus or ovaries, the point of the instrument being felt, thinly covered, through the gut. In two of the cases of this kind in which I have been consulted, there had been monthly epistaxis. No surgical interference can be of any avail in such cases; and an attempt to restore the vagina would necessarily lead to fatal results by opening the peritoneal cavity. Occasionally, if the woman has been married, the fruitless attempt at coition on the part of the husband, has caused dilatation and expansion of the urethral orifice to such an extent, that the index finger may be introduced into the cavity of the bladder. I have known this expanded urethra mistaken for the vaginal aperture, coitus effected into it, and the existence of the malformation for a long time completely overlooked. *Simultaneous* vesical and rectal exploration will always clear up the true nature of the case.

Hypertrophy of the Clitoris is occasionally met with; this organ becoming enlarged, elongated, and pendulous, and in some cases attaining an enormous size. Hargrave mentions an instance where it was found after removal to constitute a tumour weighing five pounds and a half. When the clitoris is enlarged, it may give rise to a good deal of irritation, and require excision, an operation that is often followed by rather troublesome hæmorrhage, requiring the use of the actual cautery for its arrest. The clitoris may also occasionally be the seat of epithelioma; which, however, is more commonly met with affecting the labia minora and the orifice of the vagina. In either situation excision by means of Paquelin's cautery knife is the most effectual mode of treatment.

Removal of the Clitoris, even though not enlarged, was some years ago recommended and extensively practised as a means of cure in some forms of epilepsy and of erotomania. This is an operation as unscientific as it would be to remove the glans penis for the cure of similar affections in the male, and one that the experience of the profession has proved to be as useless in its results as it is unscientific in its principle.

Tumours of various kinds are met with in the interior of the vagina, springing from its walls. These may be of a **Cystic** character; but occasionally true **Mucous Polypi** are found dependent and projecting from the side of this canal. These may most readily be removed by transfixing their base by a double silk ligature, and then strangling them. In performing this operation, however, when the tumour grows from the posterior wall, care must be taken to ascertain, by proper digital examination, that a portion of the rectum has not been dragged down into its base.

Vaginal Hæmorrhoids are occasionally, though rarely, met with. They occur chiefly towards the anterior part of the vagina, or about the lower wall of the urethra, as rounded, smooth, purple masses of enlarged and congested veins. In one case I have seen a mass of this kind in an old lady give rise to permanent incontinence of urine or dysuria, by keeping the urethral aperture patent. Destruction by Paquelin's or the galvanic cautery is the best method of treatment, care being taken not to touch the healthy mucous membrane, which must be protected by a bone speculum.

Prolapsus of the anterior or posterior wall of the vagina may occur, giving rise, in the first instance, to protrusion of the bladder, or **Cystocele**; in the other, to a **Rectocele.** In either case, but especially in the first, it occasions very serious and troublesome consequences, amongst which chronic irritation of the mucous membrane of the bladder, with perhaps phosphatic deposits in the urine, are the most marked. These protrusions may be supported by properly constructed belts or pessaries combined with the use of astringent injections.

In some cases the Surgeon may feel disposed to undertake plastic operations, in order to narrow the vaginal orifice by freely paring opposite portions of its wall, bringing together the freshened surfaces by means of the silver suture, and thus procuring narrowing of the canal and permanent support to the protruded part. The success of such operative proceedings will greatly depend on attention to details. The mucous membrane at the orifice of the vagina should be dissected off from about half an inch below the meatus on one side, to a corresponding point on the other, in a strip about an inch and a half wide; the dissection being carried well up posteriorly in the fourchette. Two or three deep, and as many superficial, sutures should be passed; the deep being left in for about five, the superficial for seven days. Great attention should be paid to cleanliness, the patient lying on her side with a catheter in the bladder communicating with an india-rubber tube to carry off the urine (Fig. 1013); and the bowels should be confined by opium for the first few days after operation.

Various Discharges connected with the female organs of generation fall under the observation of the Surgeon; these may occur from the external parts, from the mucous membrane of the vaginal canal, or from the interior of the cervix and the uterine cavity. When proceeding from the mucous membrane covering the external organs, or lining the vagina, these discharges are frequently, though not necessarily, of a gonorrhœal character; and then require to be treated in the way that has been mentioned at p. 1138, Vol. II. When they are of a simple nature, proceeding from mere excessive secretion of these parts, astringent injections, and attention to the general health, will usually succeed in effecting a cure.

Vaginal Discharges of a purulent character not unfrequently occur in young female children, as the result of constitutional debility or strumous derangement. Occasionally such discharges lead to the suspicion of the child having been improperly tampered with; and, although they may of course be occasioned by some violence inflicted on the genitals, or may even be due to gonorrhœal infection, it must be borne in mind that, in the great majority of instances, they certainly arise from constitutional conditions solely, and are in no way referable to external causes. The *Treatment* consists in attention to cleanliness, the use of warm lead-lotions, and improvement of the general health.

Discharges dependent upon unhealthy conditions of the cervix and lining membrane of the uterus usually require special treatment, for the details of which the reader may best refer to works devoted to the Diseases of Women; where a consideration of the nature and management of uterine displacements will also be found.

TUMOURS OF THE UTERUS.

The so-called Fibroid, or, more correctly, Fibro-myomatous growths, constitute by far the most common form of uterine tumour. These occur either singly, or as multiple formations affecting chiefly the fundus and body of the uterus. As a rule they develop slowly, and in the majority of instances give rise to no symptoms calling for surgical treatment; but occasionally active interference is necessitated in consequence of danger to life arising from one or more of the following conditions, viz., persistent and uncontrollable uterine hæmorrhage; rapid increase in the size of the tumour (sometimes due to cystic degeneration); or constant and severe pain caused by pressure.

The ordinary classification adopted of subperitoneal, intramural, and submucous growths, may conveniently be followed in considering the surgical treatment of these tumours.

(1.) The **subperitoneal** variety, when unaccompanied by much coexistent enlargement of the uterine body, is not uncommonly met with as a more or less distinctly pedunculated growth springing from the fundus. If of moderate size, this may readily be removed on abdominal section by securing the pedicle with a transfixing ligature of stout silk previous to division, and then suturing the cut edges of its peritoneal investment across the surface of the stump. In cases, however, in which a tumour, often of very large size, is composed of a multiple mass of subperitoneal outgrowths, involving closely the uterine body, the operation of hysterectomy is to be had recourse to. This procedure, involving the ablation of the entire mass of the tumour, including the body of the uterus together with the ovaries and tubes, has recently come to be regarded as the most satisfactory mode of dealing with such cases. The operation is performed as follows :—The tumour, having been turned out of the abdominal cavity, is held up by an assistant, while the Surgeon encircles the uterus, usually at about the level of the junction of the body and cervix, with a soft iron wire connected with a small écraseur known as Koeberlé's *serre-nœud.* Whenever possible, the ovaries and tubes should be included in the loop ; while care is required that no portion of intestine be nipped by it, and that the bladder be kept out of harm's way in front. The wire, having been properly secured, is tightened by means of the spiral screw of the *serre-nœud* sufficiently to prevent all risk of hæmorrhage ; and a stout pin is then passed through the pedicle immediately above the constricting loop, before cutting away the tumour. After this has been done, the abdominal incision is carefully closed around the stump, which is maintained in position externally by the transfixing pin. Finally the wire is again tightened by a turn or two of the screw : the stump is then surrounded by pledgets of absorbent gauze or salicylic wool, and is covered by a dry dressing of similar material. This need not be disturbed for a week, provided that no signs of moisture be detected. If all

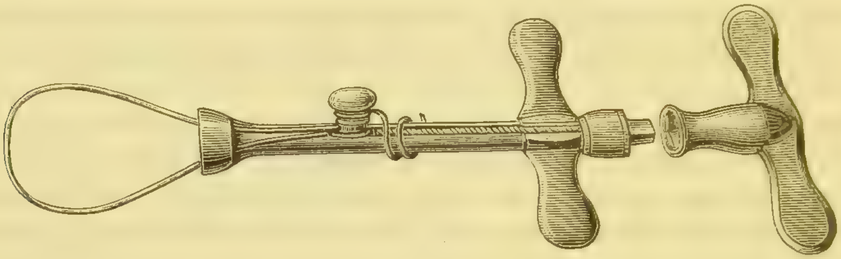


Fig. 1014.—Serre-nœud with wire.

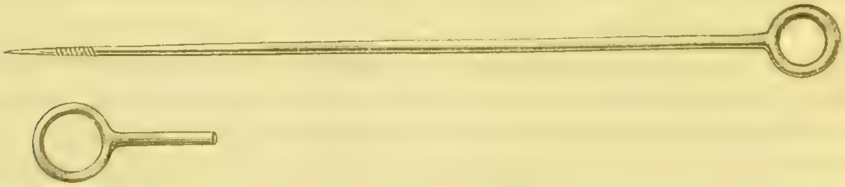


Fig. 1015.—Transfixing Pin for Uterine Stump.

go well, the wire and pin may be removed between the 10th to the 14th day ; after which, the remaining slough will usually separate in the course of another ten days or so, leaving a cavity which heals by granulation.

(2.) The **intramural** variety of fibro-myoma occurs in one of two forms. The *first* of these may be described as a more or less uniform hypertrophy of the uterine tissue, constituting the tumour commonly known as a *soft fibroid.* This enlargement is usually accompanied by profuse uterine hæmorrhage, which may occasionally necessitate active surgical interference. In such cases either one of two operations may be performed for the relief of the patient, viz., removal of the uterine appendages (ovaries and tubes) with a view to arresting hæmorrhage and promoting atrophy of the growth by premature induction of the menopause ; or else the above-described operation of hysterectomy, which is on the whole the most satisfactory mode of dealing with these tumours. The *second* form of intramural fibro-myoma consists of localized hypertrophic growths which as a rule are distinctly encapsuled. When multiple, these may occasionally give rise to a considerable tumour, requiring the same treatment as the above.

(3.) The **submucous** variety of fibro-myoma, when occurring as a more or less sessile growth, projecting into and dilating the uterine cavity, may occasionally demand surgical interference in consequence of alarming and persistent hæmorrhage. If the cervix be expanded over the protruding mass, a free incision, made through the capsule of the presenting portion, will enable the operator to shell out the tumour by a gradual process of enucleation, while firm suprapubic pressure is maintained by the hand of an assistant, in order to facilitate the extraction. This operation, often a very severe and difficult one if the growth be of any size, should be undertaken only for the relief of most urgent symptoms, since all submucous growths have a natural tendency to become polypoid in character, and thereby more easily removable.

The ordinary fibroid *polypus* is usually met with as an oval or pyriform mass, attached to the posterior aspect or fundus of the uterine cavity by means of a more or less distinct pedicle. Such growths not uncommonly give rise to repeated and dangerous hæmorrhage, often altogether disproportionate to their size. The most efficient mode of treatment consists in removal by means of a wire écraseur, of which the loop is passed round the pedicle and gradually tightened until division be effected. Unless the growth be protruding through the cervix, preliminary dilatation of this structure will be required in order to permit of the necessary manipulations.

Two other varieties of uterine polypi are met with, viz., the glandular and the cellular polyp. These usually grow from the cervix or its immediate neighbourhood, and their removal by means of the wire écraseur, or by simple torsion if of small size, commonly presents no difficulty.

It is an important rule, after all operations involving the uterine cavity, to apply pure tincture of iodine freely to the interior of the womb, in order to avoid the risks of septic mischief otherwise liable to ensue.

Malignant disease of the uterus may occur in any one of the three following forms, viz. : as glandular carcinoma (usually of the medullary type) ; as epithelioma ; or very rarely as sarcoma.

(1.) **Glandular Carcinoma**, which is much the most common form of malignant growth in this situation, may occasionally be met with as a primary affection of the *body* of the uterus ; but its more usual seat of origin is in the *cervix.* The disease commonly commences as a firm nodular growth in the cervical wall, whence it spreads both outwards and downwards, thus speedily involving the tissue of the broad ligaments and the vesico-vaginal and recto-vaginal septa, with consequent early impairment of the natural mobility of the uterus. In course of time, the pelvic organs become completely fixed and surrounded by the new growth. Destructive changes next occur in the parts implicated, usually accompanied by fœtid discharge and by occasional attacks of hæmorrhage. The amount of pain suffered varies in different cases ; it may be quite insignificant, or of a most severe and persistent character. Finally, general constitutional cachexy ensues, and the patient dies exhausted.

Treatment in advanced cases must necessarily be of a palliative nature ; the chief indications being to control hæmorrhage, relieve pain, and sustain the patient's strength.

In the earlier stages of the affection attempts are occasionally made to arrest its progress by excision and the use of the cautery, or by amputation of the cervix with the écraseur or with the galvano-caustic wire. Such methods, although perhaps justifiable, can be of little use in retarding the advance of the disease. More radical measures are required for this purpose ; and, in suitable instances, *i.e.*, when the mobility of the uterus is still unimpaired, and no trace of deposit exists in the adjoining tissue, recourse should be had without delay to one or other of the following operations, viz. : *supra-vaginal excision* of the cervix, or *complete extirpation* of the uterus.

The former of these consists in the removal not only of the entire cervix, but also of such portion of the uterine tissues above the level of the internal os as may be found implicated by the upward extension of the cervical disease. In this manner almost the entire organ may be excised, leaving merely a shell of the uterine wall with its serous covering intact. The earlier steps of the procedure are the same as those required in the operation for complete extirpation of the uterus ; which may, therefore, be at once resorted to should such a course appear desirable. For a full description of the details of both these operations, the reader should consult the works of special writers on this subject, where statistics may be found, showing the relative mortality of the two procedures, and also the degree of protection against recurrence afforded by each one of them.

(2.) **Epithelioma** of the uterus—commonly known as **cauliflower excrescence**—commences as a papillary growth on the surface of the vaginal portion of the cervix, and usually remains for a long time superficial without implicating the deeper tissues. When typically developed, it constitutes an irregular papillomatous mass which bleeds readily on being touched.

While still limited, the disease may be eradicated by the removal of the whole or even of a portion of the cervix with the écraseur ; but if once the broad ligaments have been invaded, the affection proves rapidly fatal.

(3.) **Sarcoma** of the uterus is of very rare occurrence, being met with either as a localized submucous growth, or still more rarely as a diffuse infiltration of the uterine wall. The prognosis is always unfavourable, although less speedily so than in the case of true cancer. When confined to the fundus, the removal of the projecting growths may occasionally be effected, after dilatation of the cervical canal, by means of the curette or sharp spoon, followed by the application of strong nitric acid. The only other treatment likely to prove effectual is extirpation of the entire uterus, as referred to above.

TUMOURS OF THE OVARY,

For clinical purposes, may be broadly classed in two main groups, cystic and solid. The first of these, including those in which cyst-development is the most marked feature of the growth, can be subdivided as follows: 1. Unilocular cysts; 2. Multilocular cysts; 3. Dermoid cysts; 4. Colloid cysts; 5. Cysto-sarcomata. The second group, consisting of the more or less solid formations, would include: 1. Fibroma; 2. Sarcoma; 3. Carcinoma.

Of these growths, those included in the first group constitute a large majority of the ovarian tumours met with; the multilocular variety being on the whole the most common, while dermoid cysts and cysts with colloid contents are comparatively rare. The solid tumours, referred to in the second group, occur very much less frequently than any of the above.

Tumours of the ovary may develop at almost any age, being occasionally met with in quite young children, and not very uncommonly in women who have long passed the menopause; but the largest proportion of cases occur between the ages of twenty and fifty. One or both ovaries may be affected.

If uninterfered with, the disease invariably proves fatal after a shorter or longer interval, usually within two or three years from the first development of an abdominal tumour, death occurring from gradual exhaustion due to interference with the functions of neighbouring viscera. But, in the great majority of instances, an earlier fatal termination is liable to result from some intercurrent complication or accident—such as rotation of the pedicle, inflammation of the cyst, rupture of its wall, &c., conditions which, unless promptly dealt with, must inevitably hasten the patient's death.

Diagnosis.—The differential diagnosis of ovarian tumours from the numerous abdominal enlargements which may simulate them, is too extensive a subject to be treated of here. The following may, however, be enumerated as conditions possibly requiring elimination before a definite diagnosis of ovarian disease can be arrived at: 1. Obesity, œdema of the abdominal wall, tonic spasm of the recti muscles with hysterical tympanites (phantom tumour). 2. Stercoraceous accumulation, distended urinary bladder, retained menstrual fluid, distended gall-bladder. 3. Tumour of liver, spleen, or kidney, sarcoma of the abdominal glands. 4. Peritoneal hæmotocele, abdominal or pelvic abscess. 5. Normal pregnancy, hydramnios, extra-uterine pregnancy, uterine fibro-myoma, uterine fibro-cyst, hydro- or pyo-salpynx. 6. Hydro-nephrosis, hydatid cysts, subperitoneal cysts, parovarian cysts. 7. Simple ascites, encysted dropsy of peritoneum, peritoneal cancer with ascitic fluid. The conditions enumerated in the last three of these groups are perhaps the most likely to mislead in forming an opinion.

In all cases of abdominal tumour, the patient should be examined undressed and lying upon her back with the shoulders somewhat raised and the knees drawn up. After carefully noting the salient points in the history of the case, such as the duration and rate of growth of the enlargement, its apparent seat of origin, the past and present condition of the menstrual function, &c., the Surgeon should proceed to determine the nature of the tumour by the systematic employment of the following means:—1. *Inspection:* Condition of the abdominal wall; amount of distension; shape and contour of the swelling, whether symmetrical or not, prominent anteriorly, or bulging laterally; extent of downward movement visible on deep inspiration. 2. *Percussion:* Position and extent of resonance, whether strictly limited or diffused, altered or not by change of position on the part of the patient; presence and nature of fluctuation, whether limited (encysted), or general (free fluid). 3. *Palpation:* Size, outline, and consistence of the tumour; its relative mobility; solid or with fluid contents; presence of nodular outgrowths. 4. *Auscultation:* Presence of the fœtal heart in case of suspected pregnancy; uterine souffle. 5. By *Vaginal* or *Rectal* examination may be determined whether the tumour have a pelvic connection or not; and if so, whether it be uterine, tubal, or ovarian.

Tapping or aspiration of a fluctuant abdominal tumour of doubtful origin is occasionally resorted to with a view to ascertain its nature by examination of the fluid withdrawn; and of late years an exploratory incision has been recommended in obscure cases as a more definite means of clearing up the diagnosis. This last procedure, although comparatively safe if performed with all due precautions, should by no means be rashly undertaken; but if practised, the operator must be prepared at once to proceed to the removal of the tumour, should such a step be found advisable.

Treatment of Ovarian Tumour.—1. *By Medical Means.* These cannot possibly exercise any curative influence, or in any way retard the progress of the disease. Specific treatment by mercury or iodine only hastens the progress of the malady, by breaking down the constitutional powers of the patient; and attempts at promoting the absorption of the fluid by purgatives, diuretics, &c., are invariably unsuccessful. The utmost that can be done by medical treatment in ovarian disease is to attend to the general health, and to support the patient's strength by tonics, pending the removal of the tumour.

2. *Tapping* in ovarian dropsy was formerly recommended as a palliative mode of treatment, occasionally resulting in a cure. That this may possibly follow in the case of a unilocular serous cyst of the broad ligament, cannot well be denied; but experience has shown that after withdrawal of the fluid from a true ovarian cyst, re-accumulation invariably takes place, necessitating more and more frequent repetition of the tapping, if the treatment be persisted in, until the patient finally dies exhausted. The operation, therefore, not only holds out no prospect of cure; but, as a matter of fact, its adoption is usually the precursor of a more rapidly fatal termination to the case than would otherwise occur. For, in addition to the more immediate risks attendant upon the procedure—such as wound of a vessel in the abdominal wall, in the subjacent omentum, or in the cyst-wall itself; puncture of adherent intestine or urinary bladder; escape of irritating ovarian fluid into the peritoneal cavity, &c.—tapping entails also certain remote dangers which render its adoption of very questionable advantage to the patient, even when undertaken as a means of temporary relief. Foremost among these may be mentioned adhesive peritonitis, inflammation of the cyst-wall, suppuration of its contents—conditions which, if not rapidly fatal, must very seriously complicate any future attempt to extirpate the tumour. Even though none of these untoward events should result, yet the operation, unless performed with the strictest antiseptic precautions, is always liable to induce septic contamination of the cyst-fluids, a state of things which, although not necessarily leading to any obvious trouble at the time, will surely tend to diminish the patient's chance of recovery from a subsequent ovariotomy by exposing her to the risk of septicæmia. Finally, the puncture in the cyst-wall may from

some cause or other remain unsealed, thus allowing free escape of ovarian fluid into the peritoneal cavity with all its attendant dangers, among which not the least is that of malignant infection of the peritoneum from a protruding papillomatous growth.

The above enumeration of the dangers incurred through tapping ovarian cysts is in accordance with the experience of those Surgeons who have had the fullest opportunities of judging of the results of this operation; and it is not too much to say that the procedure is one to which recourse should but very rarely be had, only when rendered justifiable by exceptional circumstances.

As a means of relieving urgent dyspnœa, tapping is clearly applicable only to unilocular cysts, or to those multilocular tumours in which one cyst-cavity largely predominates in size over its neighbours. When imperatively called for with this view, the operation should invariably be performed with the strictest antiseptic precautions, including the use of the carbolized spray, in order to obviate the risks of septic infection of the cyst-contents. The puncture may be made through the linea alba, as in the case of ordinary ascites; but not unfrequently the tumour presents more distinctly at some other part of the abdominal wall, and the point selected may be varied accordingly, care being taken always to choose a spot free from intestinal resonance, and sufficiently remote from the pubes to avoid any possibility of puncturing the bladder which may be drawn up in front of the tumour.

Incision and Drainage is a method of treatment occasionally applicable with advantage in exceptional cases of universally adherent suppurating cysts, when attempted extirpation of the tumour would entail extreme risk to life, owing to the probability of rupture of the cyst-wall during its removal—an accident most likely to prove fatal, as involving the escape of irritating septic matter into the peritoneal cavity. The operation in such instances, involves a short incision in the usual situation of sufficient extent to enable the Surgeon to judge of the closeness of the parietal adhesions, and by puncture of the cyst to determine the putrid nature of its contents. After thorough evacuation and sponging-out of the cyst-cavity with a strong solution of iodine, a glass drainage-tube should be inserted, and the incision closed by means of sutures connecting the cyst with the margins of the opening in the abdominal wall. The subsequent management of the case involves frequent withdrawal of fluid from the tube by means of a suitable syringe, and the use of some efficient antiseptic to prevent putrefaction of the discharges. Under this treatment, the cyst-cavity rapidly contracts, and finally closes entirely.

Other means of dealing with unilocular ovarian cysts have from time to time been suggested, all aiming at the same object, viz., that of inducing gradual contraction of the cyst and cohesion of its walls. But of the procedures advocated, the above described is the only one to be at all recommended, and then only in the exceptional instances alluded to. No operation, however, short of complete extirpation, can be looked upon as surely curative; since, even after incision and drainage, followed apparently by complete contraction, it not uncommonly happens that secondary cysts develop in the wall or base of the original tumour; and eventually a multilocular growth may be substituted for what was apparently in the first instance a unilocular cyst. These measures have consequently, wherever possible, given way to the safer and far more certain procedure of ovariotomy.

Ovariotomy is probably the greatest triumph of modern Operative Surgery. In its original conception, as in its ultimate perfection, this operation reflects the greatest lustre on the British School of Surgery.

Its history is curious. Its progress was slow, and was marked by those oscillations in the judgment and the favour of the Profession which frequently precede the final establishment of a great advance in practice. The operation was originally proposed, and its practicability discussed in 1762, by William Hunter. It was strongly advocated and its practicability taught by John Bell, at a later period. It is said to have been performed in France, by L'Aumonier, in 1782, in a case of "scirrhous disease with abscess" of the ovary, the patient recovering. A pupil of John Bell—McDowell of Kentucky, who is the father of ovariotomy—first performed the operation in America in 1802 ; and in all operated thirteen times. In 1823, Lizars operated for the first time in this country. But the operation, though several times repeated, fell into discredit, in a great measure owing to the imperfection of the diagnosis of the cases in which it was done, and was not revived until 1836, when Jeaffreson of Framlingham practised it successfully through a small incision only an inch and a half long. From this operation we must date the revival of ovariotomy in Great Britain. This operation was followed by others performed by King of Saxmundham, Crisp of Harleston, and West of Tonbridge. The example of these provincial Surgeons was followed by their brethren in London, and the operation was practised by many, especially by Walne, F. Bird, and Baker Brown, but with very discouraging results ; for of 162 cases collected by Robert Lee, in 60 the disease could not be removed, and of these 19 died ; whilst of the remaining 102, 42 terminated fatally. Not only did these unfavourable results discourage the Profession, but a growing belief sprang up that this mortality, great as it was, did not by any means represent the whole extent of the fatal cases, and notwithstanding that C. Clay of Manchester continued to operate, ovariotomy was in great danger of falling into such disrepute as to be excluded from ordinary surgical practice. In 1857 appears for the first time in connection with ovariotomy the name of a Surgeon, who was not only destined to revive ovariotomy, but to re-establish it firmly and definitively amongst the great operations in surgery ; for in December of that year Sir Spencer Wells performed his first operation of this kind. This case, the first of a series of 1,000 cases that he had performed up to the year 1881, led to a revival of the operation. In Sir Spencer Wells's hands, ovariotomy assumed a new shape ; its performance was guided by definite rules, the operative details were carefully worked out and systematized, and the after-treatment much improved. The results obtained showed a gradually increasing success : thus, of the first series of 100 cases published, 34 cases died and 66 recovered ; of the second series, 28 died and 72 recovered ; of the third 100 cases, 23 died and 77 recovered ; while of the last 100, completing his 1,000 cases, only 11 died and 89 recovered ; this representing in 1880 a mortality less than a third of that recorded in 1860. These results, admirable as they are, have been still further improved upon during late years by other well-known workers in this field of Surgery ; and the procedure, formerly so fatal as to be pronounced unjustifiable, is now the most successful of all great surgical operations.

In comparing the present reduced rate of mortality after ovariotomy with that which prevailed so recently as ten or twelve years ago, it will be found that the increased success now obtained, is in great measure attributable to the reduction in the number of deaths recorded from septicæmia—a cause of mortality which formerly figured so largely in ovariotomy statistics. The following are the main factors connected with the operation as now practised, which have contributed to the attainment of the result.

The *first*, and perhaps the most important of these factors in the increased success of ovariotomy, has been the general adoption of the intraperitoneal method in the treatment of the pedicle, as opposed to the extraperitoneal method by means of the clamp, which was formerly used to a very large extent. The disadvantages of the clamp are now so self-evident, that it is difficult to understand how it should so long have held its ground against the ligature. Certainly the practice of tying the pedicle with a silk thread, cutting the ends short off, and returning the stump, is the simplest, and, if properly managed, the safest plan of treatment; and it is now universally adopted in dealing with ovarian tumours. The use of the actual cautery, either alone or more commonly combined with that of the ligature, is still continued by some few operators, but appears to possess no advantage over the more usual method, even in cases where the condition of the pedicle is most favourable for its employment.

The *second* factor here requiring mention, has been the gradual abandonment of the practice of tapping ovarian cysts. There can be no doubt that this treatment formerly so commonly adopted, had much to answer for in retarding the progress of ovariotomy. The disastrous consequences of the procedure failed from some cause or other sufficiently to impress the mind of the profession at large; and, until within the last ten years, tapping was looked upon as the proper preliminary treatment before recommending abdominal section. That such a course should have appeared justifiable in the early times of ovariotomy, when the diagnosis of ovarian disease was comparatively in its infancy, is not unnatural; but, at the present day, when the study of abdominal tumours has been so greatly perfected, the fact that tapping is an operation to be looked upon with the greatest distrust, is daily becoming more generally recognised; and this belief has undoubtedly contributed to the success of ovariotomy.

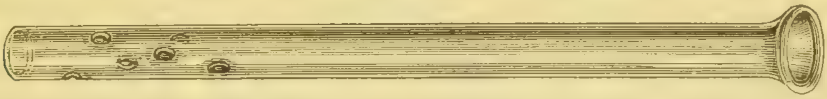


Fig. 1016.—Glass drainage-tube.

The *third* factor alluded to, viz., drainage of the abdominal cavity, practised by the insertion at the lower extremity of the abdominal incision of a glass tube reaching to the bottom of Douglas' pouch, has certainly taken a share in reducing the mortality after the operation. The utility of this method, as a means of preventing the accumulation in the peritoneal cavity of fluids liable to undergo septic changes, has long been recognised; but its value has recently been enhanced by the adoption of the plan of flushing out the peritoneal cavity with plain boiled water or with a warm solution of boracic acid—as a preliminary to the use of the tube. This treatment has, of late years, undoubtedly contributed greatly to the success of abdominal surgery;

and in putrid cases, where reliance cannot be placed on ordinary antiseptic precautions, its adoption is certainly advantageous.

The *last*, but by no means the least important, of the factors referred to as having influenced the mortality after ovariotomy, is the application of the antiseptic system to abdominal surgery. Although the utmost importance had for long been attached by all operators to the employment of the strictest hygienic measures both during and after the performance of ovariotomy, it is only within the last nine or ten years that the antiseptic treatment has been systematically applied to operations of this nature.

The extent to which it is necessary to carry out so-called strict Listerism, may still, possibly, be a matter for discussion, but of the now well-established value of antiseptics in these operations, as shown by published results, no doubt can be entertained.

The advocates for the use of the strictest antiseptic precautions in ovariotomy, recommend their employment on the following grounds, viz.: that, since their introduction, the rate of mortality has diminished; the after-treatment is simplified; and, recovery is more rapid and complete.

Those who object to the use of antiseptics, base their practice on the following statements: that they are unnecessary—the diminution in the rate of mortality being due to circumstances other than the employment of antiseptics, such as increased personal experience, the diminution in the number of cases which have been tapped before operation, the general adoption of improved methods of hygiene and cleanliness, and the employment during the operation of special means for cleansing the peritoneal cavity.

The true estimate of the relative value of these conflicting statements may be safely left to time; but meanwhile the fact remains, that the adoption of antiseptics in abdominal Surgery has been followed by a very marked improvement in the results of peritoneal operations; and further—that this increased success is mainly attributable to the reduction in the mortality from septic causes.

In the days when the results of ovariotomy were much less good than they now are, the opinion generally held was in favour of postponing any surgical interference so long as the patient was tolerably free from pain and able to move about. Of late years, however, the increasing success of the operation, together with the fuller recognition of the serious risks entailed by delay in such cases, has led to the belief that an ovarian tumour should be removed as soon as its nature and connections can be clearly ascertained, and its presence is beginning in any way to affect the patient's well-being.

Preparation of the Patient.—No special medical treatment is as a rule necessary, beyond attending to the state of the bowels. In the case, however, of a very large tumour of long standing, when the urine is scanty and highly concentrated, depositing quantities of mixed urates, benefit will be derived from the administration of full doses of citrate of potash or lithia during the forty-eight hours preceding operation, combined with the employment of a hot bath, should the skin be habitually dry and disinclined to act. Finally, a full dose of castor-oil or some equivalent aperient should be given the evening before, to be followed by an enema administered on the morning of the operation, to ensure thorough evacuation of the lower bowel.

The room selected for the operation and for subsequent occupation by the patient, must be thoroughly clean, airy, and well ventilated, if possible with an open fire-place. A trustworthy and competent nurse, accustomed to the use of the female catheter, and to the giving of nutrient injections, should be chosen to take sole charge of the case; she, as well as all concerned in the operation, ought to be completely free from any taint of recent septic contamination.

All sponges and instruments, previously well cleansed, must be immersed in a warm 2½ per cent. solution of carbolic acid, and placed within easy reach of the operator's hand. The silk employed for ligatures, sutures, &c., should be thoroughly purified by soaking in a 5 per cent. solution of the acid for an hour or two before being used. It is an important rule, for obvious reasons, carefully to count the sponges and artery-forceps in use immediately before commencing the operation, so as to prevent the possibility of any subsequent doubt as to their number.

After the bladder has been emptied by means of the catheter, the patient in her night-dress and wearing a flannel bed-jacket and warm stockings, is placed upon the operating table with her head and shoulders comfortably supported by pillows. Anæsthesia having been induced, the lower limbs wrapped in a blanket are secured by a broad strap buckled across just above the knees, while her hands are fastened on either side of the table. A thin mackintosh sheet, large enough to cover the patient entirely from the shoulders downwards, and having an opening in the centre four inches by six, coated around with adhesive material, is next applied to the abdomen, of which the skin, previously well cleansed with soap and water, should be sponged over with carbolic lotion before turning on the spray. The Surgeon, standing on the right side of the patient, is faced by his assistant on the opposite side of the table.

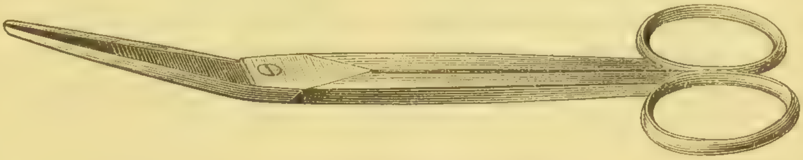


Fig. 1017.—Scissors for use in Abdominal Operations.

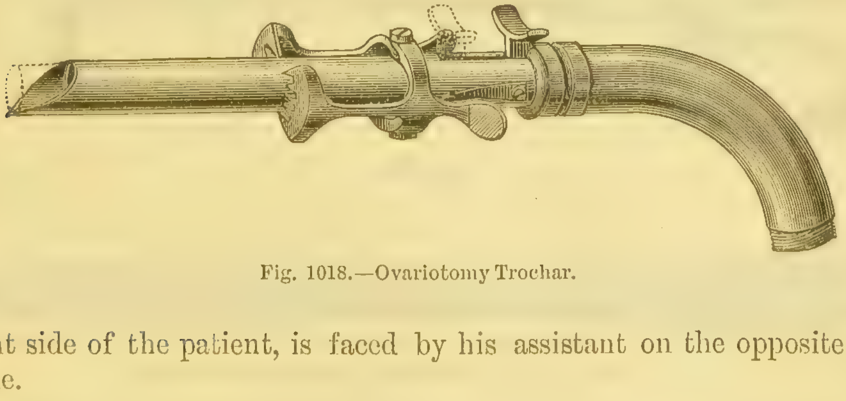


Fig. 1018.—Ovariotomy Trochar.

Operation.—No definite rule can be laid down as to the length of the incision, beyond stating that while necessarily proportionate to the size and nature of the tumour, it should in all cases be as limited as possible. A small cut, two or three inches long, extending in the mid-line to within an inch of the pubes, will suffice for the removal of any simple cyst; and, if necessary, may readily be prolonged upwards. All hæmorrhage from bleeding points in the abdominal wall having been arrested by the application of Wells's pressure-forceps, the peritoneum must be divided, care being taken to open it fairly; for, if adherent, it may readily be mistaken for the cyst-wall, and so stripped off the under surface of the abdominal muscles.

On exposing the tumour, any soft parietal adhesions in the immediate neighbourhood of the incision may be separated by the Surgeon's finger. The growth, if cystic, should then be tapped with Wells's trochar (Fig. 1018), care being taken to prevent the escape of any fluid into the abdominal cavity by fixing the edges of the puncture with the trochar-clamps, which enable the operator to extract the gradually collapsing cyst. Should this prove impracticable owing to the multilocular nature of the growth, the trochar must be carefully withdrawn after applying Nélaton's forceps (Fig. 1019), and the puncture in the cyst-wall sufficiently enlarged to permit of the Surgeon introducing his hand for the purpose of breaking down the contents of the tumour.

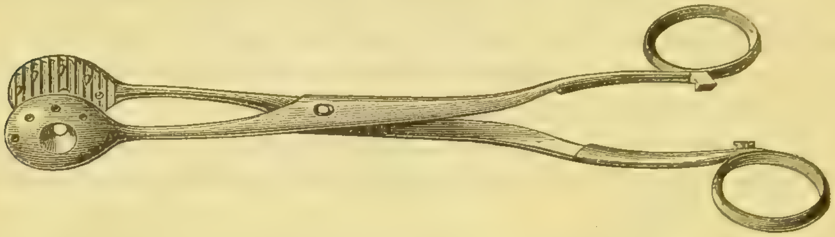


Fig. 1019.—Nélaton's Cyst-Forceps.

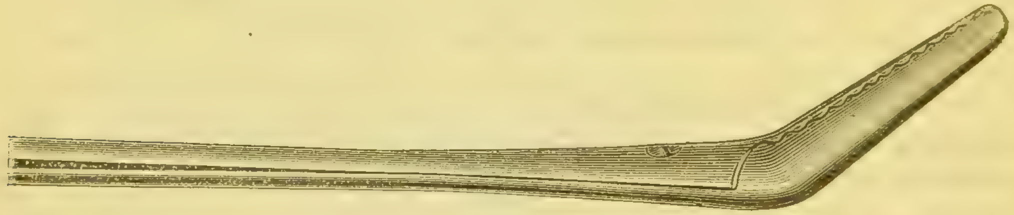


Fig. 1020.

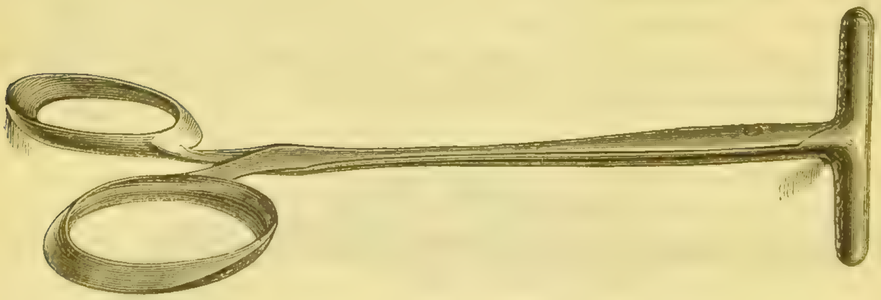
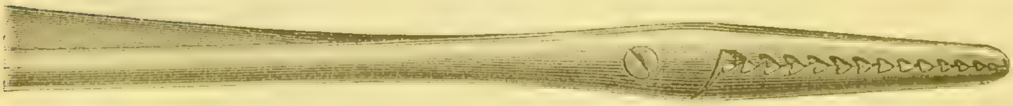


Fig. 1021.



Figs. 1020, 1021, 1022.—Variously shaped Pressure-Forceps.

If still unable to extract it, he must prolong his incision upwards, and carefully separate any parietal, omental, or intestinal adhesions which may be present, applying pressure-forceps (Figs. 1020, 1021, 1022) as required to all bleeding points. Immediately after the extraction of the tumour, a flat sponge squeezed thoroughly dry, should be introduced for the purpose of protecting the intestines and preventing their protrusion.

The pedicle is now examined and its connection with the uterus clearly defined. As a rule it is most convenient to tie it before cutting away the tumour; but, if desirable, it may be temporarily secured with strong pressure-forceps during division, and then dealt with subsequently. Either of the two methods here represented may be employed for this purpose. That shown in Fig. 1023 is the one most generally adopted. A single thread is first passed at a point just internal to the large plexus of veins in the outer edge of the pedicle, and securely tied so as to include the plexus, together with the ovarian artery which lies along this border; the pedicle is next transfixed centrally with a double ligature passed by means of the handled needle (Fig. 1025), and is tied in equal halves, care being taken that the loops interlace at the seat of puncture. In the other method—shown in Fig. 1024, the separate outer-edge ligature is usually dispensed with. The pedicle is transfixed as before, but with a needle carrying only a single thread, doubled upon itself; after withdrawal of the needle, one end of the ligature is brought half round the pedicle, passed through the projecting loop on the side opposite to its own point of exit, and thence carried onward to unite with the remaining end of the ligature round the other half of the pedicle—which is thus secured by a continuous twisted loop. Pressure-forceps are then applied to either border on the distal side of the ligatures, and the tumour is cut away. Finally a single loop of stout silk is tied firmly round the stump, either exactly in or immediately behind the groove formed by the previous ligatures. All the threads should

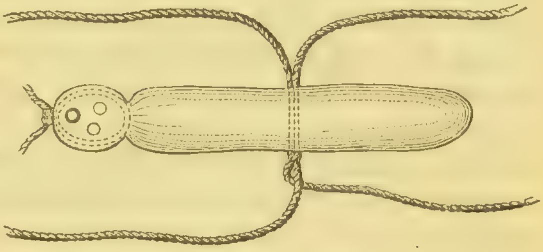


Fig. 1023.—Ligature of the Ovarian Pedicle (twisted loop).

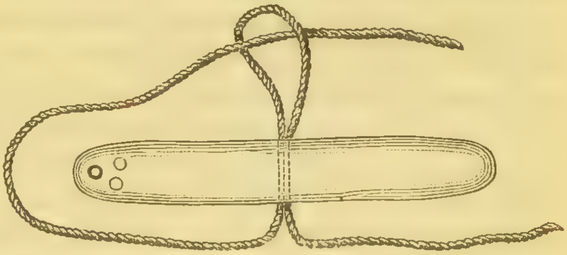


Fig. 1024.—Ligature of the Ovarian Pedicle (double loop).

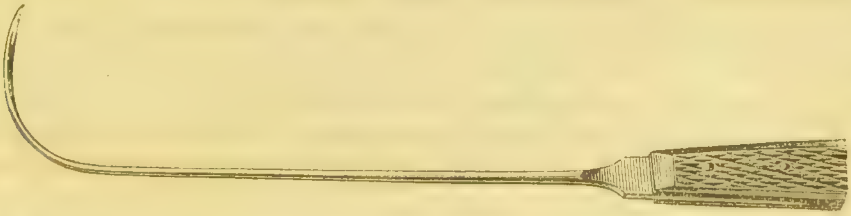


Fig. 1025.—Curved Pedicle-needle.

be cut short, and the pedicle be returned, without, however, removing the pressure-forceps, which are left on in order to facilitate the final examination of the stump before closing.

The condition of the remaining ovary should next be ascertained ; and if diseased, it should be removed.

Parietal adhesions, unless of long standing, do not as a rule require ligature, temporary compression by forceps usually sufficing for the arrest of hæmorrhage. Should there, however, be general oozing from a somewhat extensive surface, the application of a sponge moistened with strong Liq. Ferri Perchloridi will serve readily to control it. Bands of pelvic adhesions must always be tied as near as possible to their seat of origin, and cut short. Omental and intestinal adhesions need careful management ; the former should be dealt with either by transfixion and tying off in sections, or else by separate ligature of bleeding vessels ; the latter, if extensive, may require to be laced by a fine continuous suture involving only the peritoneal coat of the intestine.

The peritoneal cavity should now be thoroughly and systematically sponged out, care being especially directed to the uterine pouches, and to the iliac and lumbar regions. The pedicle is again examined to make certain that all is left secure ; the forceps holding it are removed, and it is dropped in. A small flat sponge is then introduced for the purpose of protecting the intestines during the insertion of the sutures, for which no better material can be employed than fine silk, passed at intervals of about half an inch. To ensure a satisfactory cicatrix, each stitch should include the edges of the sheath of the rectus muscles, in addition, of course, to the peritoneum, which is the most important layer of any in the wall. Before closing, all sponges and forceps are carefully counted to make sure that none are missing.

Should drainage be deemed advisable, a glass tube of the required length is introduced to the bottom of Douglas's pouch from the lower end of the abdominal incision before tying the sutures. The mouth of the tube is then covered with one or more well carbolized sponges, enveloped in a rubber sheet with a perforation in its centre which fits closely around the everted lip of the tube. (Fig. 1016.)

Finally a dry antiseptic dressing is applied and kept in place by broad straps of adhesive plaster, over which a flannel binder is fastened securely round the patient's abdomen before placing her in bed.

After-Treatment.—On recovery from the anæsthetic, an opiate should at once be administered, either in the form of a hypodermic injection of morphia, or perhaps more conveniently as the ordinary Liq. Opii, of which twenty drops may be given by the bowel, and repeated as required, usually once in every six hours, for the first three or four days. Should sickness be troublesome, nothing need be given by the mouth for the first twenty-four or thirty-six hours beyond a little ice, plain soda-water, or brandy and water ; after which milk and water may be tried, to be succeeded, if retained, by plain bread and milk. In the meantime nutrient injections of beef-tea with or without the addition of a tablespoonful of port wine, administered every three or four hours, will probably be of service ; the nurse being directed to introduce a rectal tube before each injection in order to facilitate the escape of flatus. The urine should be drawn off by the catheter four times daily for the first few days, or until the patient be able to pass it naturally. In a *drainage* case—renewal of the sponges, and withdrawal of fluid from the tube by means of a syringe with rubber tubing fitted to its nozzle, should be practised twice in each twenty-four hours until the tube is removed—usually at the end of the first forty-eight or seventy-two hours, when the opening left by it will readily close. If all be going well, ordinary light diet, such as milk-pudding, fish or chicken, may be allowed on the third or fourth day. Should there be much fever at any time, the application of an ice bladder to the head will soothe and tranquillize the patient, and promote reduction of the temperature. As a rule the bowels may be left undisturbed until they show some inclination to act, when they may be assisted by an enema. Finally the stitches should be removed on the seventh or eighth day, and the patient may be allowed to leave her bed at the end of the second week, wearing a suitable abdominal belt.

After recovery from ovariotomy, the cure is usually complete.

Oöphorectomy.—The removal of one, or possibly of both, uterine appendages (ovaries and tubes) may, in exceptional instances, be required for the relief of persistent suffering associated with tangible disease of these organs. The steps of the operation, and the details of the after-treatment, resemble in all essential features those above given in connection with ovariotomy.

Hernia of the Ovary.—It may happen that the ovary, on one or both sides, becomes displaced, and escapes from the pelvis through one of the openings which give passage to intestinal hernia. In three-fourths of the recorded cases (twenty-seven out of thirty-eight, according to Englisch of Vienna) the displacement has been inguinal. In nearly one half of the cases it was congenital ; all these were instances of inguinal displacement ; and all the instances of double ovarian hernia were inguinal and congenital.

The *Causes* of the displacement in the adult are not easily ascertained. In the congenital cases it would seem as if an abnormal descent of the ovary took place, analogous to the descent of the testis in the male.

Symptoms.—Congenital ovarian hernia is nearly always irreducible ; while in most cases of acquired displacement of the ovary, it has been possible to return the tumour into the abdomen. The swelling is generally pyriform in the inguinal region, rounder in the femoral. There is no constant diagnostic symptom ; but in several instances it has been noticed that the hernia became more tender on pressure, and larger during menstruation. At this time, also, inflammation of the ovary may take place ; and, being attended with vomiting, may lead the Surgeon to imagine that the case is one of strangulated hernia. The diagnosis here is not easy ; indeed, according to Englisch, of twenty cases, in which symptoms of strangulated hernia were present, a correct diagnosis was made in seven only. The difficulty of diagnosis would be much increased if an intestinal or omental hernia were present with the ovarian. Abscess or sloughing of the displaced ovary occasionally occurs.

Treatment.—So long as the hernia presents no special symptoms there is little or no occasion for interference, beyond the wearing of a properly fitted truss. If inflammation occur, the case must be treated on ordinary principles ; and if the ovary suppurate, the abscess should be opened. When the ovary is very painful, or has become cystic, extirpation may be practised.

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